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VEHICLE SAFETY AND YOUNG DRIVERS

STAGES 2 & 3: ANALYSIS OF YOUNG DRIVER CRASH TYPES AND VEHICLE CHOICE OPTIMISATION

by

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Abstract:
The overall aim of this study was to examine the implications of young driver vehicle choice on secondary safety outcomes. This was achieved by identifying patterns in vehicle choice by driver age and sex (Stage 1, see Watson & Newstead, in press), investigating the young driver crash profile (Stage 2), and developing and assessing scenarios for changing young driver vehicle choice to optimise road trauma outcomes (Stage 3). This report documents the outcomes of Stages 2 and 3.

The results of Stage 2 indicate that young drivers are over-represented in crashes occurring at night, single-vehicle crashes, crashes occurring in rural areas and crashes occurring on wet road surfaces. These crash types were more severe overall with the exception of crashes on wet roads. For Australian drivers aged 18-24 years old, crashes at night and single-vehicle crashes were more serious in comparison to drivers aged 25 or above. For New Zealand drivers, single-vehicle crashes involving young drivers were not more severe than single-vehicle crashes involving mature drivers. Vehicle profile analyses showed that the average crashworthiness of vehicles driven by young drivers remained the same across different crash types, including crashes occurring at different times of day.

Stage 3 demonstrated that it is possible to reduce the number of serious injuries and fatalities if the vehicle choices of young drivers move towards vehicles with high crashworthiness ratings. Three scenarios were assessed. Scenario 1 estimated the road trauma outcomes if all young drivers were driving the vehicle with the best crashworthiness rating (Scenario 1a) or a vehicle with a crashworthiness rating equal to the average crashworthiness rating of the ten most-crashworthy vehicles (Scenario 1b). Scenario 2 estimated the road trauma outcomes if all young drivers were driving the most-crashworthy vehicle within the same year of manufacture as the vehicle they crashed (Scenario 2a) or if all young drivers were driving the most-crashworthy vehicle within the same year of manufacture and vehicle market group as their crashed vehicle (Scenario 2b). Scenario 3 estimated road trauma outcomes if all young drivers' vehicles were fitted with ESC. Scenario 1a was the most effective in terms of reducing serious injuries and fatalities among young drivers. Several recommendations are made regarding real-world applications.

Key Words: (IRRD except when marked*)
Young drivers, Accident, Collision, Crash, Injury, Motor Vehicle, Motorist, Road User, Vehicle, Injury, Vehicle Occupant, Collision, Passenger Car Unit, Statistics, Chart, Driver age, Crash Type, Single-vehicle crash, Multiple vehicle crash, Unprotected road user

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EXECUTIVE SUMMARY

Around the world, road crashes are the leading cause of death among young people aged between 10 and 24 years. The World Health Organisation (WHO) has reported that nearly 400,000 people under the age of 25 are killed each year whilst millions more are injured and disabled (WHO, 2007). The main approach to reducing the crash risk of young drivers in Australia (and in other developed countries) is Graduated Driver Licensing Systems (GDLS). GDLS encompass the staged approaches required to gaining a full licence (e.g. Learner, P-plate licence), skills testing, increased enforcement measures, vehicle restrictions, and various approaches to training and education. With regard to vehicle restrictions, several states in Australia have a high power restriction for L- and P-plate drivers. Optimising young driver vehicle choice has the potential for reducing young driver crash risk. A significant amount of research already exists on the crash profile of young drivers. Overall, the research indicates that the crash profile of young drivers differs from experienced drivers, and that young drivers are over-represented in night-time and single-vehicle crashes.

The overall aim of this study was to examine the implications of young driver vehicle choice on secondary safety outcomes. This was achieved by identifying patterns in vehicle choice by driver age and sex (Stage 1, see Watson & Newstead, in press), investigating the young driver crash profile (Stage 2), and developing and assessing scenarios for changing young driver vehicle choice to optimise road trauma outcomes (Stage 3). The Stage 2 component of the study identified the types of crashes that young drivers were over-represented by comparing the proportion of crashes involving young drivers with experienced drivers. Based on this crash profile, the study aimed to understand the relationship between young drivers' vehicle choice and their crash profile.

The following four research questions were explored:

1. What type of crashes are young drivers over-represented in comparison to drivers aged 25 and above?
2. Are the crash types in which young drivers are over-represented more severe than other crash types?
3. For the crash types where young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are seriously injured in these types of crashes?
4. For crash types when young drivers are over-represented what is the distribution of vehicle age and market group of these crashed vehicles?

The data used in Stage 2 of the project were the same as the crash data used in Stage 1, except that crashes were limited to those occurring in the period 2001-2005, and separate analyses were carried out using New Zealand data. Restricting the sample to crashes occurring in the period 2001-2005 reduced the number of police-reported crashes to 1,202,089 in the 5 Australian States, 68,133 in New Zealand, hence an overall total of 1,270,222 police-reported crashes. For the crash profile analysis the age and sex of the driver was analysed in addition to the time of crash, number of road users involved, urbanisation at crash location, road geometry at crash location, and road surface at crash location. For the vehicle profile analyses the distribution of vehicle age and crashworthiness was analysed in relation to the high-risk crash situations as identified in the crash profile.

The Stage 2 analyses indicated that the crash profile of young drivers clearly differs from older drivers. The Australian analyses indicated that young drivers had more crashes at night, more single-vehicle crashes, more crashes in rural areas, and more crashes on wet roads when compared to drivers aged 25 years or older. These crash types were also more likely to be severe for all drivers, with the exception of crashes occurring on wet roads. For drivers aged 18-24 years old, crashes occurring at night, single-vehicle crashes and rural crashes were more serious when they involved young drivers in comparison to when they involved drivers aged 25 or above. Due to a strong correlation between rural crashes and single-vehicle crashes, no further analyses of the rural road crashes were undertaken. Night-time crashes and single-vehicle crashes were analysed with respect to vehicle age and crashworthiness. Young drivers were more likely to be driving a vehicle aged 6 years or more when they crashed at night and when they were involved in single-vehicle crashes when compared with vehicles crashed by mature drivers. The vehicle age profile for young drivers remained the same across crashes occurring in daylight hours and crashes occurring with other vehicles suggesting that young drivers' vehicle profile in terms of vehicle age is consistent across all times and places of use. Crashworthiness analyses also showed consistent findings to the Stage 1 report in that young drivers, and in particular young female drivers, were more likely to be driving vehicles with poor crashworthiness in comparison to drivers aged 25 years or over. This was also true in night-time and single-vehicle crashes.

The New Zealand analyses revealed that young drivers had more crashes occurring at night, more single-vehicle crashes, and more crashes on wet roads when compared to drivers aged 25 years or older. Night-time crashes and single-vehicle crashes were more likely to be severe across all age groups. It was the analysis of the third research question where differences emerged between Australia and New Zealand. For the New Zealand analyses it was found that for crashes occurring on a weekend at night, drivers aged 18-24 years were more likely to be seriously injured when compared to drivers aged 25 years or above. However, for crashes occurring on a weekday at night, drivers aged 16-20 years were more likely to be seriously injured, whereas drivers aged 21-24 years were less likely to be seriously injured when compared with experienced drivers. For the analysis of single-vehicle crashes in New Zealand, all groups of young drivers were less likely to be seriously injured in comparison to drivers aged 25 years or older. Again, this was in contrast to the Australian findings.

The Stage 2 study has demonstrated clear differences in the crash patterns of young drivers in comparison to drivers aged 25 years or above. These findings have implications for vehicle choice optimisation. The crash types that should be addressed in vehicle choice optimisation research are generally the same across Australia and New Zealand. There were slight differences in the results of the analyses of the third research question between Australia and New Zealand, but generally speaking crashes occurring at night-time and involving no other road users were the two major crash types. Night-time and single-vehicle crashes were more likely to occur among young drivers in comparison to drivers aged 25 years or above, when they do occur they were more likely to result in a serious injury for drivers of all ages, and generally speaking young drivers were more likely to be seriously injured in comparison to drivers aged 25 years or above for these crash types.

The Stage 3 component of the study aimed to build upon the outcomes of Stages 1 and 2 by considering the potential for optimising young driver vehicle choice with respect to road trauma outcomes. This was achieved by modelling three scenarios using data of serious injuries and fatalities involving young drivers. For each scenario, road trauma outcomes were measured in terms of the estimated change in the number of serious injuries and fatalities. Young drivers were defined as any driver aged between 16-24 years that had been involved in a serious injury or fatality in the period 2001-2005.

Scenario 1 estimated the road trauma outcomes if all young drivers were driving the vehicle with the best crashworthiness rating (Scenario 1a) or a vehicle with a crashworthiness rating equal to the average crashworthiness rating of the ten most-crashworthy vehicles (Scenario 1b). Scenario 2 estimated the road trauma outcomes if all young drivers were driving the most-crashworthy vehicle within the same year of manufacture as the vehicle they crashed (Scenario 2a) or if all young drivers were driving the most-crashworthy vehicle within the same year of manufacture and vehicle market group as their crashed vehicle (Scenario 2b). Scenario 3 estimated road trauma outcomes if all young drivers' vehicles were fitted with Electronic Stability Control (ESC).

The analyses carried out for Stage 3 of this study have demonstrated that it is possible to reduce the number of serious injuries and fatalities if the vehicle choices of young drivers move towards vehicles with high crashworthiness ratings. Scenario 1a was the most effective for reducing serious injures and fatalities among young drivers. The analyses also demonstrated that there is often only a small difference in price between the most crashworthy vehicle manufactured in a particular year and the prices of models manufactured in the same year that are popular choices for young drivers. The study has indicated that vehicle choice optimisation is achievable however transfer of this research knowledge to the general public is critical. Several recommendations have been provided, many of which are consistent with the aims of the 2001-2010 National Road Safety Strategy:

- The development of an initiative that aims to improve young driver vehicle choice. The initiative should be developed with the aim of allowing young drivers and their parents to make informed choices about upcoming vehicle purchases by comparing the purchase price of all vehicles with their relative vehicle safety scores;
- Discourage young drivers from driving unsafe market groups – 4WDs, light cars and sports cars;
- Encourage ESC and other technologies designed to enhance safety in vehicles driven by young drivers;
- Evaluate the effectiveness of the GDLS component that restricts high-powered vehicles;
- Undertake future research that aims to develop a vehicle safety restriction linked to the licensing system for all novice drivers. For example, restricting learner and intermediate drivers to vehicles above a particular crashworthiness or ANCAP rating;
- Conduct further research which aims to reduce the high rate of night-time crashes through vehicle choice optimisation;
- Investigate the advantages of a grey used car import program for Australia to provide young drivers with a greater range of safe vehicles for purchase;
- Develop initiatives that provide financial incentives for young drivers to purchase safer vehicles, for example, through reduced registration or insurance premiums; and,
- Investigate the application of vehicle scrappage programs for Australia, for example, the U.S based "cash for clunkers" whereby drivers are provided with financial incentives to replace their old vehicle for a newer vehicle (Hahn, 1995). The two major benefits resulting from vehicle scrappage programs are that the replacement vehicles are generally safer and also that they are more environmentally friendly than the driver's previous vehicle.

RESEARCH TEAM CONTRIBUTION

The following tasks were completed by the research team members, as listed below.

Project management – SN
Project aims and data plan – SN/JS/MW
Data preparation - JS
Data analysis – JS/MW
Report write up – MW/JS

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CONTENTS

Page No.

List of Tables

List of Figures

VEHICLE SAFETY AND YOUNG DRIVERS

STAGE 2: ANALYSIS OF YOUNG DRIVER CRASH TYPES

1. INTRODUCTION

The broad aim of this project was to examine the types of vehicles driven by young drivers and the implications of these vehicle choices on injury outcomes in crashes. This study carries on from a project funded by the Royal Automobile Club of Victoria (RACV) under its Road Safety Research Fund (Stage 1). It envisaged that the outcomes of such research will benefit vehicle safety advocacy efforts including those already in place such as the Used Car Safety Ratings Program and Australasian New Car Assessment Program (ANCAP) program by focusing specifically on young driver vehicle choice.

Key outcomes from the broader research program include:

- analysis of vehicle model selection by young drivers including an assessment of important factors influencing young driver vehicle choice;
- measurement of the impact on road safety of young driver model selection; and
- identification of appropriate countermeasures for improving young driver vehicle safety including education, legislation, model selection and vehicle technology benefits such as ESC (Electronic Stability Control) and side airbags.

1.1 Background to the problem

Around the world, road crashes are the leading cause of death among young people aged between 10 and 24 years. The World Health Organisation (WHO) has reported that nearly 400,000 people under the age of 25 are killed each year whilst millions more are injured and disabled (WHO, 2007). The crash risk of drivers aged between 17-25 years is the highest of any other group of drivers. A wealth of research demonstrates that this crash risk is highest during the first year of driving on an intermediate or provisional licence (see Figure 1), particularly in the first 6-months (Diamantopoulou, Skalova, Dyte and Cameron, 1996; Gregersen, 1996).

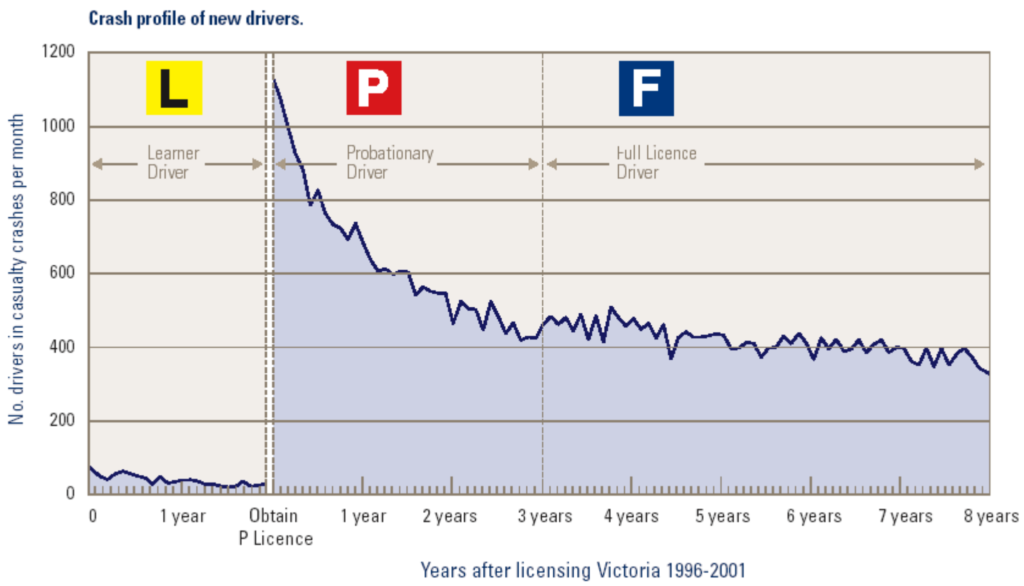

Figure 1: Relative Crash Frequency of Novice Drivers by Period of Licensure

(Source: VicRoads (2005) Young Driver Safety and Graduated Licensing Discussion Paper)

The main approach to reducing the crash risk of young drivers in Australia (and in most other developed countries) is Graduated Driver Licensing Systems (GDLS). GDLS encompass the staged approaches required to gaining a full licence (e.g. Learner, P-plate licence), skills testing, increased enforcement measures, vehicle restrictions, and various approaches to training and education. With regard to vehicle restrictions several states in Australia have a high power restriction for L- and P-plate drivers. For example in Victoria, a P-plate driver is unable to drive a vehicle with the following characteristics:

- an engine of eight or more cylinders;
- a turbo charged or super charged engine;
- selected high performance six cylinder engines; or
- an engine that has been modified to increase the vehicle's performance

Breaches of the above vehicle restrictions incur a fine and loss of demerit points. Such restrictions are only likely to affect a subset of young drivers – those that seek to drive powerful vehicles. However all young drivers pose a high crash risk, so minimum vehicle requirements (i.e. vehicle safety features) that target all young drivers are arguably more effective than vehicle power restrictions alone, which target a small subset of young drivers. Vehicle safety can be generally categorised as vehicle crash avoidance (primary safety) and vehicle crash protection (secondary safety). An example of a primary safety feature is traction control; airbags are an example of a secondary safety feature. Primary safety is therefore concerned with avoiding the crash altogether, whereas secondary safety is concerned with protecting the occupants in the vehicle when a crash occurs and hence reducing the severity of the crash overall.

In association with GDLS, optimising young driver vehicle choice has the potential for reducing young driver crash risk and also for reducing the severity of injury outcomes when young drivers are involved in crashes. The aim of vehicle choice optimisation is that young drivers are driving a vehicle that can best protect them in the event of a crash. Vehicle choice optimisation for young drivers translates to a significant shift in the vehicle fleet, and such a shift has inherent policy implementation issues. As such, more research is required before recommendations for vehicle choice optimisation are made. Firstly it is important to understand young drivers' crash profile in relation to vehicle choice. Crash profile refers to the identification of trends between driver demographics (i.e. driver age and sex) and crash characteristics (e.g. location of crash, number of vehicles involved). A young driver crash profile (with the overall aim of informing vehicle choice optimisation research) should identify types of crashes in which young drivers are over-represented, in comparison to older drivers, and subsequently identify the make/model of vehicles that young drivers are crashing. Put simply if vehicle choice is directed towards avoiding and reducing the severity of crashes then a detailed understanding of current crash patterns is required. A brief review of the literature on the crash profile of young drivers and also on the vehicle choice of young drivers will be provided before outlining the aims of the study in more detail.

A significant amount of research already exists on the crash profile of young drivers. Overall the research indicates that the crash profile of young drivers differs from experienced drivers. A key study was conducted by MacDonald, Bowland, and Hancock (1994) using casualty and Federal Office of Road Safety data from Victoria, NSW, and SA and also a crash database from the USA. The analyses focussed on identifying differences between young drivers and experienced drivers that occur consistently across databases, and secondly, consistent differences between daytime and night-time crash patterns.

MacDonald et al., (1994) found that the proportion of young drivers involved in the following crashes were higher than experienced drivers; on curves as opposed to straight road sections, off the road or on the road shoulder, off path on straight section (particularly at night), off path on a curve or turning section (particularly at night), single-vehicle crashes (particularly at night), in vehicle to vehicle crashes when the young drivers was in the striking vehicle (only in daytime and only in the USA database), in urban rather than rural areas and in 60 km/h speed zones (Australian Fatals database only), at non-signalised intersections, straight roads, reversing or stationary, loss of control (particularly at night), at-fault crashes, not wearing a seat-belt, vehicles aged above nine years, weekend crashes, night-time crashes. Young drivers were less likely to be involved in a crash in a new vehicle. They were also less likely to be involved in a crash in wet weather during the day but were more likely to be involved in a crash in wet weather at night. MacDonald et al. found that the most consistent finding was the over-representation of young drivers in single-vehicle crashes. The study therefore provides evidence based on an analysis of Australian data that young drivers do drive older vehicles and have a higher proportion of single-vehicle crashes, and crashes at night.

The study by MacDonald et al. is one of few studies that specifically addresses the crash profile of young drivers. Many other studies investigate the crash profile of young drivers through GDLS evaluations. These studies indicate that night-time crashes and single-vehicle crashes can be reduced under stricter GDLS. Interestingly, evaluating the effects of mandating a zero BAC using pre- and post-legislation crash data has indicated that a zero BAC reduces the incidence of night-time single-vehicle crashes (Senserrick & Whelan, 2003). The research findings are consistent with the research of MacDonald et al., indicating that young drivers are clearly over-represented in night-time and single-vehicle crashes.

Ferguson (2003) reviewed the literature on young driver crash risk factors that were not addressed by Graduated Driver Licensing Systems (GDLS). The following high-risk factors were identified: risky driving, risk perception/hazard perception/and driving skill evaluation, effects of fatigue, seat-belt use, vehicle choice, and in-vehicle distraction. With regard to vehicle choice Ferguson pointed out that young drivers tend to drive older and smaller vehicles. This is consistent with two other studies in the USA (Cammisa, Williams, & Leaf, 1999; Williams, Leaf, Simons-Morton, & Hartos, 2006). Ferguson indicated that most parents and young drivers were not aware of the importance of choosing a safe vehicle to prevent a crash and protect their young driver in the event of a crash. Ferguson emphasised the importance of education to include vehicle choice. The research from the USA indicates that young drivers not only have a higher crash risk than any other driving group, but that the vehicles that they drive provide poor crash protection.

The Stage 1 report (Watson & Newstead, in press) analysed the Used Car Safety Ratings data to identify patterns in vehicle choice by driver age and sex. The results demonstrated that the secondary safety performance of vehicles driven by young drivers was poorer than vehicles driven by experienced drivers. Specifically the results showed that young drivers overall were more likely to drive older vehicles, and young females were more likely to drive small cars whereas young males were more likely to drive large cars. Finally, the crashworthiness of young drivers' vehicle choice was inferior to vehicles driven by experienced drivers. Furthermore, crashworthiness of vehicles driven by young drivers was inferior to vehicles driven by experienced drivers even within each vehicle age group. That is, young drivers were crashing in vehicles of poor crashworthiness regardless of the age of the vehicle.

1.2 Aims and Research Questions

The overall aim of this study was to examine the implications of young driver vehicle choice on secondary safety outcomes. The aim of this component of the study (Stage 2) was to identify the types of crashes that young drivers were over-represented by comparing the proportion of crashes involving young drivers with experienced drivers. Based on this crash profile, the study aimed to understand the relationship between young drivers' vehicle choice and their crash profile.

The following four research questions were explored:

1. What type of crashes are young drivers over-represented in comparison to drivers aged 25 or above?
2. Are the crash types in which young drivers are over-represented more severe than other crash types?
3. For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?
4. For crash types in which young drivers are over-represented, what is the distribution of vehicle age and market group of these crashed vehicles?

These research questions aimed to understand the relative severity of crashes where young drivers are over-represented, and also the distribution of vehicle age and market group for these crashes. For all of these research questions the effect of gender is explored within the young driver group.

2. METHOD

2.1 Crash Data Sample

2.1.1 Crash Data Overview

The data used in Stage 2 of the project were the same as the crash data used in Stage 1, except that crashes were limited to those occurring in the period 2001-2005 and separate analyses were carried out using New Zealand data. It was important to analyse New Zealand data separately to identify any differences between the findings when compared to the Australian results. The data used in Stage 1 was compiled for the Used Car Safety Ratings project (Newstead, Cameron & Watson, 2007) and described the driver demographics and crash profiles of the 3,000,691 police reported crashes occurring in New South Wales, Victoria, Queensland, South Australia and Western Australia, and the 181,880 police reported crashes occurring in New Zealand in the period 1987-2005. For a more-detailed description of these data, the reader is referred to the report for Stage 1 of the project.

Restricting the sample to crashes occurring in the period 2001-2005 reduced the number of police-reported crashes to 1,202,089 in the 5 Australian States, 68,133 in New Zealand, hence an overall total of 1,270,222 police-reported crashes. Table 1 shows the number of crashes occurring during this period by jurisdiction and crash year.

Table 1: Year of crash by jurisdiction for the sample of crashes analysed using 5 Australian states and New Zealand data

Crash Year	Jurisdiction							
	NSW	VIC	QLD	WA	SA	NZ	5 States	Total
2001	86,931	22,150	39,554	59,039	58,843	11,562	266,517	278,079
2002	85,723	22,829	28,410	59,114	60,344	13,661	256,420	270,081
2003	78,849	24,584	29,286	59,822	47,530	14,556	240,071	254,627
2004	76,089	23,869	30,949	63,069	34,826	14,323	228,802	243,125
2005	73,108	9,758	30,877	63,042	33,494	14,031	210,279	224,310
2001-2005	400,700	103,190	159,076	304,086	235,037	68,133	1,202,089	1,270,222

The analyses have been conducted on vehicles involved in all crashes that occurred in the period 2001-2005 in the six jurisdictions, as well as for subsets of this sample based on the injury status of the driver. Definitions of injury status are in keeping with those of Stage 1 and are the same as those used in the Used Car Safety Ratings project (Newstead, Cameron & Watson, 2007). Specifically, a vehicle was said to be involved in an injury crash if the driver of that vehicle received an injury of any severity, while a vehicle was said to be involved in a serious casualty crash if the driver of the vehicle was admitted to hospital or killed as a result of the crash. The injury severity outcome for the crash involved vehicle was defined only in terms of the injury status of the driver of a vehicle because, as explained by Newstead, Watson & Cameron (2006), NSW crash data only enabled the injury status of drivers to be deduced.

Table 2 also shows that there were 238,981 injured drivers across the five Australian jurisdictions, meaning that 963,108 (80%) of the 1,202,089 drivers were not injured. A consequence of defining the injury severity status of the crashed vehicle in terms of the injury status of the driver was that for many of the 963,108 vehicles involved in police reported crashes in which the driver was not injured, an occupant other than the driver may have been injured or a road user that was not an occupant of the vehicle may have been injured. Indeed, for Victoria all 103,190 vehicles involved in police reported crashes were involved in a crash in which a road user was injured as the Victorian police reported data only includes data on crashes in which a road user was injured. In comparison, the minimum criteria for inclusion in NSW and Queensland police-reported crash datasets is that a vehicle was towed from the crash scene or somebody was injured. For South Australia and Western Australia, property damage only crashes are included in each data set provided property costs exceeded $1,000, but this increased to $3,000 for South Australia from 2003 onwards. However, there were several reasons why it was decided that defining the injury severity for vehicles involved in police reported crashes in terms of the injury status of the driver was appropriate. Firstly, this definition was in keeping with definitions used in previous reports that used data from the Used Car Safety Ratings; secondly this definition also eliminated bias associated with some types of vehicles having different occupancy rates; and thirdly it meant NSW data, for which the injury status of non-drivers could not be determined, could be included in the analysis.

Table 2: Driver injury severity by jurisdiction for the sample of crashes analysed

Injury Severity	Jurisdiction							
	NSW	VIC	QLD	WA	SA	NZ	5 States	Total
Seriously Injured	**	12,993	12,687	7,138	3,316	6,578	36,134	42,712
Injured	78,359	49,482	43,418	44,351	23,371	36,625	238,981	275,606
All Severities*	400,700	103,190	159,076	304,086	235,037	68,133	1,202,089	1,270,222

* Including not injured; ** It was not possible to determine how many injured drivers were seriously injured in NSW

Table 2 also shows the number of crashed vehicles in the sample analysed in which the driver was seriously injured and the number in which the driver received an injury of any severity. For NSW, it was not possible to estimate the number of vehicles for which drivers were seriously injured. This was because in 1998 the Roads and Traffic Authority (RTA) of NSW identified inaccuracies in the coding of the variable related to injury severity in the NSW police reported crash data. As a result, since 1998 the RTA have reported the injury severity of road users involved in police-reported crashes as either uninjured, injured or fatally injured. Therefore, it was not possible to determine whether a road user injured in a crash in NSW from 1999 onwards was seriously injured. As a result of this, when analysing the relationship between driver age and crash type for serious casualty crashes, only data from Victoria, Queensland, WA, SA, and NZ were examined. It can be seen that there were 36,134 cases in which drivers from one of the four Australian jurisdictions was seriously injured and 6,578 cases of a New Zealand driver being seriously injured.

Table 3 shows the distribution of the age and sex of drivers for the sample of crashes analysed in Stage 2. From Table 3, it can be seen that the sex of the driver could not be determined for 74, 856 records in the Australian data; however most of these drivers were not classified as young drivers. It can also be noted that of the 1,202,089 drivers in the sample of crashed vehicles in Australia, 288,919 (24%) belonged to the young driver demographic.

Table 3: Distribution of driver demographics by jurisdiction for the sample of crashes analysed

Sex	Age	Jurisdiction							
		NSW	VIC	QLD	WA	SA	NZ	5 States	Total
Female	16-17	4,185	170	1,123	3,855	3,180	1,438	12,513	13,951
	18-20	14,114	5,022	7,914	13,354	8,276	2,619	48,680	51,299
	21-24	15,653	5,212	8,154	13,356	8,943	2,708	51,318	54,026
	25+	98,867	31,157	45,103	94,384	60,139	19,297	329,650	348,947
	Other	140	37	52	70	6,566	252	6,865	7,117
	Subtotal	132,959	41,598	62,346	125,019	87,104	26,314	449,026	475,340
Male	16-17	9,057	413	2,271	5,941	5,423	2,787	23,105	25,892
	18-20	25,916	7,048	12,796	17,734	12,896	5,186	76,390	81,576

	21-24	27,203	7,063	12,078	17,032	13,230	4,668	76,606	81,274
	25+	170,156	44,015	61,049	126,283	86,243	27,391	487,746	515,137
	Other	696	74	170	154	13,266	422	14,360	14,782
	Subtotal	233,028	58,613	88,364	167,144	131,058	40,454	678,207	718,661
Unknown	16-17	3	0	0	22	3	4	28	32
	18-20	34	1	2	68	9	18	114	132
	21-24	44	5	0	94	22	25	165	190
	25+	34,630	2,973	8,348	11,738	14,677	1,315	72,366	73,681
	Other	2	0	16	1	2,164	3	2,183	2,186
	Subtotal	34,713	2,979	8,366	11,923	16,875	1,365	74,856	76,221
M, F or U	16-17	13,245	583	3,394	9,818	8,606	4,229	35,646	39,875
	18-20	40,064	12,071	20,712	31,156	21,181	7,823	125,184	133,007
	21-24	42,900	12,280	20,232	30,482	22,195	7,401	128,089	135,490
	25+	303,653	78,145	114,500	232,405	161,059	48,003	889,762	937,765
	Other	838	111	238	225	21,996	677	23,408	24,085
	Total	400,700	103,190	159,076	304,086	235,037	68,133	1,202,089	1,270,222

2.1.2 Vehicle Secondary Safety Performance

Measures of secondary safety performance that were used in Stage 1 were also used in Stage 2 of the project. These measures estimate a vehicle’s ability to protect its own occupants in the event of a crash (crashworthiness) and the risk of injury a vehicle poses to other road users in a crash (aggressivity). The Used Car Safety Ratings program (Newstead, Cameron & Watson, 2007) provides regular updates of both aggressivity and crashworthiness ratings for different models of vehicles and the different years of manufacture. For more detailed information on the crashworthiness and aggressivity ratings used in Stage 2, see Section 2.4 of Stage 1 of the project.

2.2 Data Analysis Variables

2.2.1 Overview

Table 4 displays all variables that were used in the analyses. Variables were included in the analyses based on a combination of:

- Data that is recorded after a crash occurs, and;
- How the data available relates to research into crash risk factors

Table 4: List of variables used in analysis

Variable Category	Variable Type	Breakdown of variable type
Demographic Variables	Driver age	16-17 years, 18-20 years, 21-24 years, and 25+
	Sex	male, female
Crash Characteristics	Time of day	weekend night, weekend day, weekday night, weekday day
	Crash type	single-vehicle, multiple vehicle, unprotected road user, other
	Urbanisation of crash location	metropolitan area, rural area
	Road geometry at crash location	intersections, non-intersection
	Road surface at crash location	wet, dry (Australian data), wet, icy, dry (New Zealand data)
Vehicle Choice	Market Vehicle Group	unknown, 4WD (compact, large or medium), commercial (ute or van), large, luxury, medium, people mover, small, light, sports
	Vehicle age	Less than 3 years, 3 to 5 years, 6 to 10 years, 11 to 15 years, 16 years and over, unknown
	Crashworthiness	Poor, good
	Crash Severity	All crashes, serious injury crashes

2.2.2 Driver Demographics

As can be seen from Table 4, driver age is categorised into four groups. The crash data does not contain the licence status of the driver. Therefore it is not possible to provide a distribution of licence status separated by age. This would be informative because as demonstrated in Figure 1, crash risk varies greatly between L- and P-plate drivers. Based on state licensing laws, and assuming that the drivers in this sample generally gain their L-plate and P-plate licence close to the minimum entry age, some observations can be made about the licence make-up of the four age groups. It is assumed that the youngest (16 – 17 year olds) group would comprise the most number of L-plate drivers of all groups. There would also be some newly licensed P-plate drivers in those jurisdictions where the minimum age to gain a P-plate licence is 17 years (i.e. all jurisdictions except Victoria where the minimum age is 18 years). The second group (18-20 year olds) would mainly comprise P-plate drivers, with some L-plate drivers and some fully licensed drivers. The third group (21-24 year olds) would mainly comprise fully licensed drivers with some P-plate and, to a lesser extent, L-plate drivers. The fourth group is the experienced or older driver comparison group. It is estimated that the majority of drivers in this group are fully licensed.

2.2.3 Crash Characteristic Definitions

It was necessary to categorise crash types using broad categories because variables describing the characteristics of crashes were not consistent across each of the six jurisdictions that contributed data. Each of the following sections describe how each of the crash type categories described in Table 4 were derived using each jurisdiction's definitions of crash type.

2.2.3.1 Time of crash

Each of the police reported crash datasets contained variables related to the date on which the crash occurred and the time of the crash and these variables were used to categorise each crash-involved vehicle into one of the following four groups:

- ***Weekday-day*** crashes that occurred on a Monday to Friday between 6am and 7:59pm;
- ***Weekday-night*** crashes that occurred on Sunday to Thursday from 8pm to 11:59pm or from Monday to Friday from 12am to 5:59am;
- ***Weekend-day*** crashes occurring on Saturday or Sunday from 6am to 7:59pm; and
- ***Weekend-night*** crashes that occurred on Friday or Saturday from 8pm to 11:59pm or Saturday or Sunday from 12am to 5:59am.

For the Australian analysis the time of day of the crash could not be calculated for 2,964 crashed vehicles in the combined Australian dataset. This meant that the analyses relative to time of day were based on 1,199,125 (99.7%) of the 1,202,089 crashed vehicles.

For the New Zealand analysis the time of day of the crash could not be calculated for 634 crashed vehicles. This meant that the analyses were based on 67,499 (99.1%) of the 68,133 crashed vehicles.

2.2.3.2 Crash type

Each jurisdiction used different methods of characterising how vehicles involved in the crash impacted with each other. For example, in Victoria, Definition for Classifying Accident (DCA) codes are used by police to describe crashes, while in New South Wales, the Road User Movement codes are used. Queensland and Western Australia use a set of codes that are similar to the DCA codes used in Victoria. Slight differences between jurisdictions in the way crashes were defined means that there is probably some inconsistency across jurisdictions as to how a crash will fall into the above four categories. However, in general, a multiple vehicle crash was a crash in which the vehicle struck another vehicle (including motorcycles, bicycles, trains, ridden animals and heavy vehicles), while a single-vehicle crashes was a crash in which the vehicle either did not strike another vehicle or struck a parked vehicle. A crash in which a vehicle struck a pedestrian was defined as an unprotected road user crash. The "other" category was generally reserved for incidents involving a person falling from a vehicle, a vehicle being struck by a missile or a load from another vehicle and incidents involving runaway vehicles. Of the 1,202,089 crashed vehicles in the Australian sample, only 5,161 (0.4%) could not be categorised due to missing data.

Of the 68, 133 crashed vehicles in the New Zealand sample, only 67,996 (99.84%) could be categorised due to missing data.

2.2.3.3 Urbanisation of crash location

The police reported crash data for each of the five Australian jurisdictions provided information on the location of the crash. These data were used to classify crashes into those that occurred in metropolitan areas and those that occurred in rural areas. Limitations of the data meant that 159,096 (13.2%) of the 1,202,089 crashed vehicles could not be classified into one of the two categories, while 842,314 occurred (70.1%) in metropolitan areas and 200,679 (16.7%) occurred in rural areas.

2.2.3.4 Road geometry at crash location

The crash data supplied by each of the five Australian jurisdictions contained information on the geometry of the road at the site where each crash occurred. However, the manner in which crash locations were classified was not consistent across jurisdictions. For the purposes of this study, the variable related to the road geometry for each jurisdiction was classified into two broad categories: intersections or non-intersections. The types of locations that were classified as intersections include cross road intersections, T-intersections, Y-junctions, roundabouts, multiple leg intersections and rail crossings. All other locations were classified as not being intersection locations except for cases with missing values in variables related to the geometry of roads at the crash location and cases in which road geometry was classified simply as "other". There were only a small number of crashed vehicles for which the crash location could not be classified as either an intersection or a non-intersection, i.e. for Australian data only 24,680 (2.1%) of the 1,202,089 crashed vehicles could not be classified as occurring at either an intersection or a non-intersection location.

2.2.3.5 Road surface at crash location

All the police reported crash databases from the five Australian jurisdictions contained data on the condition of the road surface at the crash location. Almost all the crashes (approximately 98%) occurred on sealed roads. Therefore, it was decided that only two categories would be used to describe road surface conditions: whether the road was wet or dry at the time of the crash. Of the 1,202,089 crashes in the sample analysed, only 9,428 (0.8%) could not be classified into one of these two categories, of the remaining vehicles, 988,229 (82.2%) were travelling on dry roads when they crashed while 204,432 (17.0%) crashed on wet roads.

3. RESULTS

As noted in Section 1.3, the following research questions were explored:

1. What type of crashes are young drivers over-represented in comparison to drivers aged 25 or above?
2. Are the crash types in which young drivers are over-represented more severe than other crash types?
3. For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?
4. For crash types in which young drivers are over-represented, what is the distribution of vehicle age and market group of these crashed vehicles?

3.1 Time of Crash

3.1.1 What types of crashes are young drivers over-represented?

Table 5 presents the distribution of the time of crashes occurring in Australia by age group, separated by sex, for all crash severities. Table 5 indicates that in comparison to drivers aged 25 years or above, young drivers were over-represented in crashes occurring on a weekend at night and on a weekday at night.

For example, only 5.1% of all drivers aged 25 years or above crashed their vehicles at night on a weekend, compared to 14.3% of 16-17 year old drivers, 11.0% of 18-20 year olds and 9.2% of 21-24 year olds. Only 7.2% of drivers aged 25 years or above crashed their vehicles at night on a weekday in comparison with 11.6% of 16-17 year old drivers, 12.0% of 18-20 year olds and 10.9% of 21-24 year olds. The same trends were also observed when young male drivers were compared to older male drivers and when young female drivers were compared to older female drivers.

The analysis presented in Table 5 was also replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young drivers in Australia. Young drivers in New Zealand were clearly over-represented in crashes occurring on a weekend at night and on a weekday at night compared to drivers aged 25 years or older. Table B5 of Appendix B presents results analogous to Table 5 but for New Zealand crash data.

Table 5: Distribution of time of crash by driver age and sex for all five jurisdictions and for all crash severities, Australia

Age/sex groups	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
Male					
16-17	3,650 (15.8%)	4,211 (18.3%)	2,937 (12.7%)	12,242 (53.1%)	23,040 (100%)
18-20	9,890 (13.0%)	13,382 (17.6%)	10,175 (13.3%)	42,784 (56.1%)	76,231 (100%)
21-24	8,525 (11.2%)	13,733 (18.0%)	9,798 (12.8%)	44,357 (58.0%)	76,413 (100%)
25+	25,791 (5.3%)	88,991 (18.3%)	37,622 (7.7%)	334,253 (68.7%)	486,657 (100%)
Unknown	790 (5.5%)	2,363 (16.5%)	817 (5.7%)	10,385 (72.3%)	14,355 (100%)
All age	48,646 (7.2%)	122,680 (18.1%)	61,349 (9.1%)	444,021 (65.6%)	676,696 (100%)
Female					
16-17	1,415 (11.3%)	2,454 (19.7%)	1,175 (9.4%)	7,438 (59.6%)	12,482 (100%)
18-20	3,830 (7.9%)	8,624 (17.8%)	4,742 (9.8%)	31,374 (64.6%)	48,570 (100%)
21-24	3,170 (6.2%)	9,098 (17.8%)	4,173 (8.1%)	34,776 (67.9%)	51,217 (100%)
25+	9,676 (2.9%)	56,876 (17.3%)	14,970 (4.6%)	247,398 (75.2%)	328,920 (100%)
Unknown	190 (2.8%)	1,122 (16.3%)	244 (3.6%)	5,308 (77.3%)	6,864 (100%)
All age	18,281 (4.1%)	78,174 (17.4%)	25,304 (5.6%)	326,294 (72.8%)	448,053 (100%)
Female, Male or Unknown					
16-17	5,070 (14.3%)	6,669 (18.8%)	4,116 (11.6%)	19,694 (55.4%)	35,549 (100%)
18-20	13,729 (11.0%)	22,034 (17.6%)	14,933 (12.0%)	74,219 (59.4%)	124,915 (100%)
21-24	11,713 (9.2%)	22,854 (17.9%)	13,990 (10.9%)	79,236 (62.0%)	127,793 (100%)
25+	45,311 (5.1%)	157,617 (17.8%)	63,927 (7.2%)	620,611 (69.9%)	887,466 (100%)
Unknown	1,384 (5.9%)	3,794 (16.2%)	1,542 (6.6%)	16,682 (71.3%)	23,402 (100%)
All age	77,207 (6.4%)	212,968 (17.8%)	98,508 (8.2%)	810,442 (67.6%)	1,199,125 (100%)

3.1.2 Are the crash types where young drivers are over-represented more severe than other crash types?

The results presented in Table 5 above indicated that young drivers were over-represented in crashes occurring at night (both on a weekend and on a weekday). This over-representation in night-time crashes was observed in both Australia and New Zealand. To determine if crashes occurring on a weekend at night or on a weekday at night were more severe than day-time crashes the percentage of crashes of all severities that occurred at night (Table 5) were compared to the percentage of serious crashes that occurred at night (see Table 6 below). Table 5 showed that 6.4% and 8.2% of crashes of all severities occurred on a weekend at night and on a weekday at night respectively, compared with 11.6% and 14.6% of serious crashes (Table 6). This indicates that crashes at night (both on a weekend and on a weekday) were more likely to result in a serious injury than crashes occurring on a weekend during the day and on a weekday during the day.

The analysis presented in Table 6 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young drivers in Australia. Specifically 9.2% and 9.8% of crashes of all severities occurred on a weekend at night and on a weekday at night respectively, compared with 14.2% and 15.5% of serious crashes. This indicates that crashes at night (both on a weekend and on a weekday) were more likely to be serious crashes than crashes during the day. Table B6 of Appendix B presents results analogous to Table 6 but for New Zealand crash data.

Table 6: Distribution of time of crash by driver age and sex for all five jurisdictions, for serious casualty crashes only, Australia

Age/sex groups	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
Male					
16-17	139 (26.1%)	91 (17.1%)	107 (20.1%)	196 (36.8%)	533 (100%)
18-20	614 (22.6%)	484 (17.8%)	612 (22.5%)	1006 (37%)	2716 (100%)
21-24	684 (24.8%)	415 (15.1%)	701 (25.4%)	956 (34.7%)	2756 (100%)
25+	1537 (11.4%)	2403 (17.8%)	2103 (15.6%)	7423 (55.1%)	13466 (100%)
Unknown	21 (23.9%)	23 (26.1%)	24 (27.3%)	20 (22.7%)	88 (100%)
All age	2995 (15.3%)	3416 (17.5%)	3547 (18.1%)	9601 (49.1%)	19559 (100%)
Female					
16-17	57 (14.7%)	94 (24.2%)	43 (11.1%)	195 (50.1%)	389 (100%)
18-20	283 (12.8%)	401 (18.2%)	328 (14.9%)	1195 (54.1%)	2207 (100%)
21-24	198 (9.9%)	390 (19.5%)	279 (14%)	1130 (56.6%)	1997 (100%)
25+	627 (5.3%)	2143 (18.3%)	1046 (8.9%)	7913 (67.5%)	11729 (100%)
Unknown	5 (13.5%)	4 (10.8%)	8 (21.6%)	20 (54.1%)	37 (100%)
All age	1170 (7.2%)	3032 (18.5%)	1704 (10.4%)	10453 (63.9%)	16359 (100%)
Female, Male or Unknown					
16-17	196 (21.3%)	185 (20.1%)	150 (16.3%)	391 (42.4%)	922 (100%)
18-20	898 (18.2%)	886 (18%)	940 (19.1%)	2201 (44.7%)	4925 (100%)
21-24	883 (18.6%)	805 (16.9%)	980 (20.6%)	2087 (43.9%)	4755 (100%)
25+	2164 (8.6%)	4551 (18%)	3154 (12.5%)	15358 (60.9%)	25227 (100%)
Unknown	26 (20.6%)	27 (21.4%)	32 (25.4%)	41 (32.5%)	126 (100%)
All age	4167 (11.6%)	6454 (18%)	5256 (14.6%)	20078 (55.8%)	35955 (100%)

3.1.3 For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?

The results presented in Section 3.1.2 indicate that young drivers in Australia and New Zealand are over-represented in night-time crashes in comparison to drivers aged 25 years or above, and crashes during this time are more severe for all ages. To determine if crashes at night are more severe for young drivers when compared to drivers aged 25 years or above, the proportion of night-time crashes that resulted in a serious injury or fatality were compared across young drivers and older drivers. Table 7 indicates that crashes occurring at night on a weekend were less likely to be serious for 16-17 year old drivers (3.87%) when compared to drivers aged 25 years or older (4.78%), while crashes occurring at night on a weekend were more likely to be serious for 18-20 year old (6.54%) and 21-24 year old drivers (7.54%) when compared to drivers aged 25 years or older. A similar pattern was observed for crashes occurring on a weekday at night.

The analysis presented in Table 7 was replicated using New Zealand crash data (see Table B7 of Appendix B). The pattern of results using New Zealand data was generally consistent with the pattern described for young drivers in Australia. Crashes occurring at night on a weekend were slightly less likely to be serious for 16-17 year olds (13.19%) when compared to drivers aged 25 years or older (14.81%), while crashes occurring on a weekend at night involving drivers aged 18-20 years (15.38%) and 21-24 years (16.38%) were more likely to be serious when compared to drivers aged 25 years or older (14.81%). Interestingly, crashes at night on a weekday were slightly more likely to be serious for 16-17 years old drivers (15.72%) and 18-20 year old drivers (15.58%)

when compared to drivers aged 25 years or older (15.43%). However, crashes occurring on a weekday at night were less likely to be serious for 21-24 year old drivers (14.74%) in comparison with drivers aged 25 years or older (15.43%). These results are inconsistent with results observed in the Australian data.

Table 7: Distribution of crashes occurring at night on weekends and at night on weekdays for males and females separated by serious and all crash severities, Australia

Weekend Night			
Age	Serious Crash	All Crash Severities	% of crashes that are serious
16-17	196	5,070	3.87%
18-20	898	13,729	6.54%
21-24	883	11,713	7.54%
25+	2,164	45,311	4.78%
All ages	4,141	75,823	5.46%
Weekday Night			
	Serious	All Crash Severities	% of crashes that are serious
16-17	150	4,116	3.64%
18-20	940	14,933	6.29%
21-24	980	13,990	7.01%
25+	3,154	63,927	4.93%
All ages	5,224	97,511	5.36%

3.1.4 For crash types in which young drivers are over-represented what is the distribution of vehicle age and market group for the crashed vehicles?

To determine whether the profile of vehicles driven by young drivers is contributing to the increased severity of injury outcomes for young drivers involved in night-time crashes in comparison to when mature drivers are involved in night-time crashes, Table 8 shows the average vehicle age for young drivers involved in serious crashes. The results show that 80.8% of young male drivers involved in serious injury crashes on a weekend at night were driving a vehicle aged 6 years or older. This is compared with 80.4% of young male drivers involved in serious injury crashes overall, 72.6% of all male drivers involved in serious injury crashes, and 76.1% of all male drivers involved in serious injury crashes on a weekend at night. This confirms the results of the Stage 1 report which demonstrated that young male drivers were more likely to be crashing older vehicles when compared to older male drivers. These results also show that the vehicle age profile for young male drivers involved in serious crashes on a weekend at night is the same as when this group of drivers are involved in serious crashes at any time. A chi-square test has confirmed that there is no strong statistical difference between young male drivers' distribution of vehicle ages and time of crash [χ^2 (12, N= 5233) = 18.55 p=.10].

The analysis presented in Table 8 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young drivers in Australia. The proportion of young drivers involved in serious crashes on a weekend at night that were driving vehicles six years or older was almost the same as the proportion of young drivers crashing at any time who were driving a vehicle aged six years or older. Similarly, a greater proportion of young drivers who were involved in serious crashes were driving older cars when compared with drivers of all ages involved in serious crashes. An interesting difference between Australia and New Zealand was that across all groups of drivers, the proportion of New Zealand drivers who were driving vehicles aged six years or older was much higher than the analogous proportion of Australian drivers. For example, 91.1% of drivers involved in serious crashes in New

Zealand were driving vehicles aged six years or older, compared with 71.0% of Australian drivers. Table B8 of Appendix B presents results analogous to Table 8 but for New Zealand crash data.

Table 8: Distribution of time of crash by vehicle age group and sex for all serious injury crashes for drivers aged 16-24 years, Australia

Sex	Vehicle Age	Weekend Night	Weekend Day	Weekday Night	Weekday Day
Male	0-3 years	88 (7%)	73 (8.6%)	116 (9.3%)	161 (8.6%)
	3 to 5 years	154 (12.2%)	105 (12.3%)	144 (11.6%)	184 (9.8%)
	6 to 10 years	323 (25.6%)	189 (22.2%)	277 (22.3%)	428 (22.8%)
	11 to 15 years	373 (29.6%)	261 (30.7%)	379 (30.5%)	564 (30%)
	16 years & over	323 (25.6%)	223 (26.2%)	324 (26.1%)	544 (28.9%)
	Unknown	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)
	Total	1261 (100%)	851 (100%)	1241 (100%)	1881 (100%)
Female	0-3 years	47 (9.8%)	85 (11.2%)	64 (11.1%)	251 (11.4%)
	3 to 5 years	67 (13.9%)	96 (12.7%)	88 (15.3%)	305 (13.9%)
	6 to 10 years	118 (24.5%)	181 (23.9%)	131 (22.7%)	563 (25.6%)
	11 to 15 years	120 (24.9%)	221 (29.2%)	157 (27.2%)	585 (26.6%)
	16 years & over	129 (26.8%)	175 (23.1%)	137 (23.7%)	493 (22.4%)
	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	481 (100%)	758 (100%)	577 (100%)	2197 (100%)
M, F or Unknown					
	0-3 years	135 (7.7%)	158 (9.8%)	180 (9.9%)	412 (10.1%)
	3 to 5 years	223 (12.8%)	201 (12.5%)	232 (12.8%)	490 (12%)
	6 to 10 years	441 (25.3%)	371 (23%)	408 (22.4%)	992 (24.3%)
	11 to 15 years	493 (28.3%)	482 (29.9%)	536 (29.5%)	1149 (28.2%)
	16 years & over	452 (25.9%)	398 (24.7%)	461 (25.4%)	1037 (25.4%)
	Unknown	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)
	Total	1744 (100%)	1610 (100%)	1818 (100%)	4080 (100%)

Similar results also follow for young female drivers. For example, Table 8 shows that 76.2% of young female drivers involved in serious injury crashes on a weekend at night were driving a vehicle aged 6 years or older, compared with 75.0% of young female drivers involved in serious injury crashes overall, 69.1% all female drivers involved in serious injury crashes, and 72.6% of all female drivers involved in serious injury crashes on a weekend at night. Consistent with the results discussed above for young male drivers, the results for females confirms the findings of the Stage 1 report which demonstrated that young female drivers were more likely to be driving older vehicles than older female drivers. These results also show that the vehicle age profile for young female drivers involved in serious crashes on a weekend at night is the same as when this group of drivers are involved in serious crashes at any time. A chi-square test has confirmed that there is no strong statistical difference between young female drivers' distribution of vehicle ages and time of crash [χ^2 (12, N= 4013) = 9.96 p=.62].

The analysis presented in Table 8 for female drivers was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young female drivers in Australia. Analysis investigating the vehicle age profile of crashes occurring at night on a weekday was also carried out for Australia and New Zealand. The pattern of results was similar to those observed in the analysis of night-time crashes on weekends. Analogous analyses using Australian data investigating the vehicle profile for crashes occurring on a weekday at night were carried out. All patterns were that identified for the analysis of weekend night crashes were replicated in the weekday night analysis.

Because the market group of more than 50% of vehicles involved in serious injury crashes for young drivers were unable to be classified (i.e. defined as "Unknown"), it is not profitable to interpret analysis on vehicle market group (see Appendix A). Instead, an analysis of the average crashworthiness of young drivers' vehicles when involved in serious injury crashes was carried out. Only 59.4% of crashed vehicles were able to be assigned a valid crashworthiness estimate based on their model identifier and their year of manufacture, while when restricted to vehicles in which the driver was seriously injured, only 42.0% were able to be assigned a crashworthiness rating. However, more accurate interpretations regarding the safety of vehicles being driven by young drivers can be made by using the reduced sample defined by crashworthiness rather than the reduced sample defined by market group. In the following analyses, vehicles were grouped into high and low crashworthiness categories based on whether the values were above or below the median crashworthiness value for all vehicles in the sample (i.e. for crashes of all severities). The median crashworthiness value of the sample was 3.363%. Vehicles with a crashworthiness estimate greater or equal to this value were classified as having "poor" crashworthiness, while vehicles with an estimate less than the median were classified as having a "good" crashworthiness.

Table 9 presents the median split of vehicle crashworthiness for young drivers only for all serious crashes, separated for males and females and by time of crash. It can be seen from Table 9 that 63.5% of young male drivers involved in serious crashes at night on a weekend were driving vehicles in the poor crashworthiness category. This is compared with 65.7% young male drivers involved in serious injury crashes overall, 56.2% of all male drivers involved in serious injury crashes, and 57.4% of all male drivers involved in serious injury crashes on a weekend at night. This confirms the results of the Stage 1 report which demonstrated that young male drivers were crashing in vehicles of poorer crashworthiness than older male drivers. These results also show that the vehicle crashworthiness for young male drivers involved in serious crashes on a weekend at night is similar to that for when this group of drivers are involved in serious crashes at any time. A chi-square test has confirmed that there is no statistical difference between the distribution of vehicle crashworthiness ratings and time of crash for young male drivers [χ^2 (3, N= 2418) = 2.9 p=.40].

Table 9: Distribution of time of crash by vehicle crashworthiness and sex for all serious injury crashes for drivers aged 16-24 years, Australia

Sex	Crashworthiness	Weekend Night	Weekend Day	Weekday Night	Weekday Day
Male	Poor	363 (63.5%)	276 (67.8%)	353 (64.5%)	596 (66.8%)
	Good	209 (36.5%)	131 (32.2%)	194 (35.5%)	296 (33.2%)
	Total	572 (100%)	407 (100%)	547 (100%)	892 (100%)
Female	Poor	178 (79.5%)	290 (76.3%)	233 (80.9%)	869 (76.1%)
	Good	46 (20.5%)	90 (23.7%)	55 (19.1%)	273 (23.9%)
	Total	224 (100%)	380 (100%)	288 (100%)	1142 (100%)
M, F or Unknown					
	Poor	541 (67.9%)	567 (72%)	586 (70.2%)	1467 (72.1%)
	Good	256 (32.1%)	221 (28%)	249 (29.8%)	569 (27.9%)
	Total	797 (100%)	788 (100%)	835 (100%)	2036 (100%)

A similar pattern of results was identified for young female drivers. For example, it can be seen from Table 9 that 79.5% of young female drivers involved in serious injury crashes on a weekend at night were driving a vehicle in the poor crashworthiness category, compared with 77.2% of young female drivers involved in serious injury crashes overall, 65.0% of all female drivers involved in serious injury crashes, and 71.2% of all female drivers involved in serious injury crashes on a weekend night. This confirms the results of the Stage 1 report which demonstrated that young female drivers were crashing in vehicles of poorer crashworthiness than older female drivers, and, that they were crashing in vehicles of poorer crashworthiness than young male drivers. These results also show that the vehicle crashworthiness for young female drivers involved in serious crashes on a weekend at night is similar to that for when this group of drivers are involved in serious crashes at any time. This indicates that vehicles involved in crashes occurring on a weekend at night have similar average crashworthiness to vehicles crashing at other times. A chi-square test has confirmed that there is no statistical difference between young female drivers' distribution of vehicle crashworthiness ratings and time of crash (χ^2 (3, N= 2034) = 3.85 p=.27).

Analogous analyses using Australian data for crashes occurring on a weekday at night were also carried out. The patterns that were observed for the analysis of weekend night crashes were replicated in the weekday night crash analysis.

3.1.5 Summary of findings for time of crash

The findings from the time of crash indicates that young drivers were over-represented in crashes occurring at night (both on a weekday and on a weekend) in comparison with drivers aged 25 or above. The night-time crashes were also more severe in general when comparing across all driver ages, and when comparing young drivers with drivers aged 25 years or above. Similar results were found for the New Zealand analysis, except that New Zealand crashes occurring on a weekday at night were less likely to be serious for 21-24 year old drivers in comparison with drivers aged 25 years or above. All young drivers were more likely to be driving older vehicles when involved in a serious crash which is consistent with the Stage 1 report. The vehicle age profile for young drivers involved in serious crashes at night is the same as when this group of drivers are involved in serious crashes at any time. The New Zealand analysis for vehicle age profile was consistent with the Australian findings. Interestingly the proportion of New Zealand drivers who were crashing in vehicles aged six years or older was much higher than the analogous proportion of Australian drivers.

The crashworthiness analysis confirmed the results of the Stage 1 report which demonstrated that young drivers were crashing in vehicles of poorer crashworthiness than older drivers. These results also show that the vehicle crashworthiness for young drivers involved in serious crashes at night is similar to that for when this group of drivers are involved in serious crashes at any time. Females were more likely to be crashing in vehicles of poor crashworthiness when involved in serious crashes than males.

3.2 Crash Type

3.2.1 What types of crashes are young drivers over-represented?

The second crash characteristic that was analysed was crash type. This analysis was concerned with identifying patterns in the number and type of other road users involved in young driver crashes. Table 10 presents the distribution of crash type by driver age group, separated by sex, for all crash severities. Overall Table 10 demonstrates that in Australia, both young male and young female drivers are over-represented in single-vehicle crashes in comparison with drivers aged 25 years or above.

More specifically it can be seen that 35.5% of crash involved male drivers aged 16-17 years were involved in single-vehicle crashes, compared with only 14.3% of crash-involved male drivers aged 25 years or older. Therefore, when male drivers were involved in crashes, they were more likely to be involved in single-vehicle crashes if they were young drivers than if they were aged 25 or older. The same result was also true for females. For both male and female drivers, the proportion of crash-involved drivers that were involved in single-vehicle impacts appeared to decrease with advancing age.

Table 10: Distribution of road user involvement of crash by driver age and sex for all five jurisdictions and for all crash severities, Australia

Age/sex groups	Single-vehicle	Multiple Vehicle	Unprotected Road User	Other	Total
Male					
16-17	8,184 (35.5%)	14,489 (62.9%)	290 (1.3%)	60 (0.3%)	23,023 (100%)
18-20	20,354 (26.7%)	54,218 (71.2%)	1,326 (1.7%)	230 (0.3%)	76,128 (100%)
21-24	17,140 (22.5%)	57,334 (75.1%)	1,561 (2.0%)	305 (0.4%)	76,340 (100%)
25+	69,438 (14.3%)	402,029 (82.7%)	11,592 (2.4%)	2,827 (0.6%)	485,886 (100%)
Unknown	1,941 (13.5%)	12,154 (84.7%)	94 (0.7%)	159 (1.1%)	14,348 (100%)
All age	117,057 (17.3%)	540,224 (79.9%)	14,863 (2.2%)	3,581 (0.5%)	675,725 (100%)
Female					
16-17	3,002 (24.1%)	9,278 (74.4%)	155 (1.2%)	34 (0.3%)	12,469 (100%)
18-20	8,131 (16.8%)	39,485 (81.4%)	753 (1.6%)	137 (0.3%)	48,506 (100%)
21-24	6,907 (13.5%)	43,123 (84.3%)	914 (1.8%)	183 (0.4%)	51,127 (100%)
25+	36,227 (11%)	284,056 (86.6%)	6,297 (1.9%)	1,528 (0.5%)	328,108 (100%)
Unknown	727 (10.6%)	6,043 (88.1%)	46 (0.7%)	47 (0.7%)	6,863 (100%)
All age	54,994 (12.3%)	381,985 (85.4%)	8,165 (1.8%)	1,929 (0.4%)	447,073 (100%)
Female, Male or Unknown					
16-17	11,192 (31.5%)	23,788 (67.0%)	445 (1.3%)	94 (0.3%)	35,519 (100%)
18-20	28,508 (22.9%)	93,791 (75.2%)	2,081 (1.7%)	368 (0.3%)	124,748 (100%)
21-24	24,078 (18.9%)	100,585 (78.8%)	2,479 (1.9%)	488 (0.4%)	127,630 (100%)
25+	144,815 (16.4%)	713,511 (80.6%)	21,093 (2.4%)	6,218 (0.7%)	885,637 (100%)
Unknown	3,961 (16.9%)	19,038 (81.4%)	167 (0.7%)	228 (1%)	23,394 (100%)
All age	212,554 (17.8%)	950,713 (79.4%)	26,265 (2.2%)	7,396 (0.6%)	1,196,928 (100%)

The analysis presented in Table 10 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young drivers in Australia. In New Zealand, young drivers were clearly over-represented in single-vehicle crashes when compared with drivers aged 25 years or above. Table B10 of Appendix B presents results analogous to Table 10 but for New Zealand crash data.

3.2.2 Are the crash types where young drivers are over-represented more severe than other crash types?

As discussed above young drivers are clearly over represented in single-vehicle crashes. To determine if single-vehicle crashes were more severe than crashes that were not single-vehicle crashes, the percentage of crashes of all severities that were single-vehicle crashes was compared to the percentage of serious injury crashes that were single-vehicle crashes. Table 11 shows the distribution of serious injury crashes by road user involvement. It can be seen that 17.8% (Table 10) of crashes of all drivers were single-vehicle crashes compared with 40.8% (Table 11) of serious crashes. Therefore single-vehicle crashes are more severe than crashes involving other road users.

The analysis presented in Table 11 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern described for young drivers in Australia. Specifically 22.1% of crashes of all severities were single-vehicle crashes compared with 43.5% of serious crashes. This sharp increase in serious injury single-vehicle crashes compared with all crash severities indicates that single-vehicle crashes are clearly more likely to be serious crashes than crashes involving other road users. Table B9 of Appendix B presents results analogous to Table 11 but for New Zealand crash data.

Table 11: Distribution of road user involvement of crash by driver age and sex for all five jurisdictions and for all serious injury crashes, Australia

Age/sex groups	Single-vehicle	Multiple Vehicle	Unprotected Road User	Other	Total
Male					
16-17	375 (69.8%)	160 (29.8%)	1 (0.2%)	1 (0.2%)	537 (100%)
18-20	1651 (60.7%)	1058 (38.9%)	2 (0.1%)	8 (0.3%)	2719 (100%)
21-24	1624 (58.8%)	1128 (40.8%)	4 (0.1%)	6 (0.2%)	2762 (100%)
25+	5752 (42.6%)	7635 (56.5%)	28 (0.2%)	96 (0.7%)	13511 (100%)
Unknown	61 (70.1%)	26 (29.9%)	0 (0%)	0 (0%)	87 (100%)
All age	9463 (48.2%)	10007 (51%)	35 (0.2%)	111 (0.6%)	19616 (100%)
Female					
16-17	206 (52.3%)	188 (47.7%)	0 (0%)	0 (0%)	394 (100%)
18-20	901 (40.8%)	1299 (58.8%)	3 (0.1%)	8 (0.4%)	2211 (100%)
21-24	719 (35.9%)	1276 (63.7%)	2 (0.1%)	5 (0.2%)	2002 (100%)
25+	3373 (28.7%)	8298 (70.7%)	13 (0.1%)	50 (0.4%)	11734 (100%)
Unknown	22 (59.5%)	15 (40.5%)	0 (0%)	0 (0%)	37 (100%)
All age	5221 (31.9%)	11076 (67.6%)	18 (0.1%)	63 (0.4%)	16378 (100%)
Female, Male or Unknown					
16-17	581 (62.4%)	348 (37.4%)	1 (0.1%)	1 (0.1%)	931 (100%)
18-20	2554 (51.8%)	2357 (47.8%)	5 (0.1%)	16 (0.3%)	4932 (100%)
21-24	2344 (49.2%)	2405 (50.5%)	6 (0.1%)	11 (0.2%)	4766 (100%)
25+	9140 (36.2%)	15946 (63.1%)	43 (0.2%)	149 (0.6%)	25278 (100%)
Unknown	84 (67.2%)	41 (32.8%)	0 (0%)	0 (0%)	125 (100%)
All age	14703 (40.8%)	21097 (58.6%)	55 (0.2%)	177 (0.5%)	36032 (100%)

3.2.3 For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?

The results of the crash type analysis clearly demonstrate that young drivers in Australia and New Zealand are over-represented in single-vehicle crashes, and these types of crashes are more severe for all ages. To determine if single-vehicle crashes are more severe for young drivers in comparison to drivers aged 25 years or above, the proportion of all crash severities was compared for serious injury crashes by driver age. It can be seen from Table 12 that single-vehicle crashes involving 16-17-year old drivers were less likely to be serious injury crashes than single-vehicle crashes involving drivers aged 25 years or above. However, both 18-20 year olds and 21-24 year olds were more likely to be involved in a single-vehicle crash resulting in a serious injury (in comparison to drivers aged 25 years or above).

The analysis presented in Table 12 was replicated using New Zealand crash data. The pattern of results using New Zealand data was not consistent with the pattern as described for young drivers in Australia. That is, single-vehicle crashes were less likely to be serious for all young New Zealand drivers when compared to drivers aged 25 years or older. Therefore, no further analyses will be carried out on the New Zealand data for vehicle profile of single-vehicle crashes. Table B12 of Appendix B presents results analogous to Table 12 but for New Zealand crash data.

Table 12: Distribution of single-vehicle crashes for males and females separated by serious and all crash severities, Australia

Age	Serious	All	% of crashes that are serious
16-17	581	11192	5.19%
18-20	2554	28508	8.96%
21-24	2344	24078	9.74%
25+	9140	144815	6.31%
All ages	14619	208593	7.01%

3.2.4 For crash types in which young drivers are over-represented what is the distribution of vehicle age and market group for these crashed vehicles?

To determine whether the profile of crashed vehicles driven by young drivers is contributing to the increased severity of injury outcomes for young drivers involved in single-vehicle crashes, Table 13 shows the average vehicle age for young drivers only, and for serious injury crashes. It can be seen from Table 13 that 80.4% of young male drivers involved in serious injury single-vehicle crashes were driving a vehicle aged 6 years or older. This is compared with 80.4% of young male drivers involved in serious injury crashes overall, 72.6% of all male drivers involved in serious injury crashes, and 74.5% of all male drivers involved in serious injury single-vehicle crashes. This confirms the results of the Stage 1 report which demonstrated that young male drivers were more likely to be crashing in older vehicles in comparison to older male drivers. These results also show that the vehicle age profile for young male drivers involved in single-vehicle serious crashes is the same as when this group of drivers are involved in serious crashes with other road users. A chi-square test has failed to reveal a statistically significant relationship between vehicle age and crash type for young male drivers [χ^2 (4, N= 5263) = 7.37 p=.11].

Table 13: Distribution of crash type by vehicle age group and sex for all serious injury crashes for drivers aged 16-24 years, Australia

Sex	Vehicle Age	Single-vehicle	Multiple Vehicle	Unprotected road user	Other
Male	0-3 years	265 (8.3%)	172 (8.4%)	1 (20%)	1 (7.1%)
	3 to 5 years	354 (11.1%)	232 (11.3%)	1 (20%)	2 (14.3%)
	6 to 10 years	773 (24.3%)	445 (21.6%)	1 (20%)	1 (7.1%)
	11 to 15 years	954 (30%)	622 (30.2%)	2 (40%)	5 (35.7%)
	16 years and over	829 (26.1%)	587 (28.5%)	0 (0%)	5 (35.7%)
	Unknown	1 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	3176 (100%)	2058 (100%)	5 (100%)	14 (100%)
Female	0-3 years	175 (11%)	270 (11.2%)	0 (0%)	2 (18.2%)
	3 to 5 years	207 (13%)	343 (14.2%)	2 (40%)	3 (27.3%)
	6 to 10 years	381 (23.8%)	614 (25.5%)	1 (20%)	1 (9.1%)
	11 to 15 years	453 (28.3%)	631 (26.2%)	1 (20%)	3 (27.3%)
	16 years and over	382 (23.9%)	551 (22.9%)	1 (20%)	2 (18.2%)
	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	1598 (100%)	2409 (100%)	5 (100%)	11 (100%)
M, F or Unknown					
	0-3 years	440 (9.2%)	442 (9.9%)	1 (10%)	3 (12%)
	3 to 5 years	564 (11.8%)	575 (12.9%)	3 (30%)	5 (20%)
	6 to 10 years	1155 (24.2%)	1060 (23.7%)	2 (20%)	2 (8%)
	11 to 15 years	1407 (29.4%)	1253 (28%)	3 (30%)	8 (32%)
	16 years and over	1211 (25.3%)	1138 (25.5%)	1 (10%)	7 (28%)
	Unknown	1 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	4778 (100%)	4468 (100%)	10 (100%)	25 (100%)

Similar results were found for young female drivers. For example, Table 13 shows that 76% of young female drivers involved in serious injury single-vehicle crashes were driving a vehicle aged 6 years or older, compared with 75% of young female drivers involved in serious injury crashes overall, 69.1% of all female drivers involved in serious injury crashes, and 70.3% of all female drivers involved in serious injury single-vehicle crashes. Consistent with the results discussed above for young male drivers, the results for females confirm the findings of the Stage 1 report which demonstrated that young female drivers are more likely to be crashing in older vehicles than older female drivers. These results also show that the vehicle age profile for young female drivers involved in serious single-vehicle crashes is the same as when this group of drivers are involved in serious with other road users. A chi-square test has failed to reveal a statistically significant relationship between vehicle age and crash type for young female drivers [χ^2 (4, N= 4028) = 4.75 p=.31].

As pointed out for the analysis of time of crash (see section 3.1.4), because the market group of more than 50% of vehicles involved in serious injury crashes for young drivers were unable to be classified (i.e. defined as "Unknown"), it is not profitable to interpret analysis on vehicle market group. Instead, an analysis of the average crashworthiness of young drivers' vehicles when involved in a serious injury crash was carried out.

Table 14 displays the median split of vehicle crashworthiness for young drivers only for all serious crashes, separated for males and females and road users involved. It can be seen from Table 14 that 63.3% of young male drivers involved in serious injury single-vehicle crashes were driving vehicles in the poor crashworthiness category. This is compared with 65.7% young male drivers involved in serious injury crashes overall, and 56.2% of all male drivers involved in serious injury crashes and

56.2% of all male drivers involved in serious injury single-vehicle crashes. This confirms the results of the Stage 1 report which demonstrated that young male drivers were more likely to be crashing in vehicles of poorer crashworthiness than older male drivers. A chi-square test has revealed that, for young male drivers, there is a statistically significant relationship between vehicle crashworthiness and crash type [χ^2 (1, N= 2438) = 9.77 p=.001]. Specifically, for young male drivers, vehicles of good crashworthiness are over represented in single-vehicle crashes when compared to other types of crashes. However, the reader should keep in mind that the majority of young male drivers involved in serious single-vehicle crashes still are driving vehicles of poor crashworthiness.

Table 14: Distribution of crash type by vehicle crashworthiness and sex for all serious injury crashes for drivers aged 16-24 years

Sex	Crashworthiness	Single-vehicle	Multiple Vehicle	Unprotected Road User	Other
Male	Poor	946 (63.3%)	641 (69.4%)	3 (75%)	7 (77.8%)
	Good	548 (36.7%)	282 (30.6%)	1 (25%)	2 (22.2%)
	Total	1494 (100%)	923 (100%)	4 (100%)	9 (100%)
Female	Poor	575 (72.2%)	998 (80.5%)	2 (66.7%)	3 (60%)
	Good	221 (27.8%)	242 (19.5%)	1 (33.3%)	2 (40%)
	Total	796 (100%)	1240 (100%)	3 (100%)	5 (100%)
M, F or Unknown					
	Poor	1523 (66.4%)	1640 (75.8%)	5 (71.4%)	10 (71.4%)
	Good	770 (33.6%)	524 (24.2%)	2 (28.6%)	4 (28.6%)
	Total	2293 (100%)	2164 (100%)	7 (100%)	14 (100%)

Similar results were revealed for young female drivers. For example, Table 14 shows that 72.2% of young female drivers involved in serious injury single-vehicle crashes were driving a vehicle in the poor crashworthiness category, compared with 77.2% of young female drivers involved in serious injury crashes overall, 65.0% all female drivers involved in serious injury crashes, and 62.8% of all female drivers involved in serious injury single-vehicle crashes. This confirms the results of the Stage 1 report which demonstrated that young female drivers were more likely to be crashing in vehicles of poor crashworthiness than older female drivers, and, that they were crashing in vehicles of poorer crashworthiness in comparison to young male drivers. A chi-square test has revealed that, for young female drivers, there is a statistically significant relationship between vehicle crashworthiness and crash type [χ^2 (1, N= 2047) = 18.51 p=.001]. Specifically, for young female drivers, vehicles of good crashworthiness are over represented in single-vehicle crashes when compared to other types of crashes. However, the majority of young female drivers involved in serious single-vehicle crashes still are driving vehicles of poor crashworthiness.

3.2.5 Summary of findings for crash type

For Australia, the results in Section 3.2 clearly indicated that young drivers were over-represented in single-vehicle crashes in comparison with drivers aged 25 years or above. Single-vehicle crashes were also more severe in general when comparing across all driver ages, and when comparing young drivers with drivers aged 25 years or older, except for drivers aged 16-17 years. Analyses of the New Zealand data indicate that young drivers were also over-represented in single-vehicle crashes and these were more severe in general when comparing across all driver age groups. However, single-vehicle crashes were less serious for young drivers when comparing with single-vehicle crashes involving drivers aged 25 years or older. Vehicle profile analyses using Australian data indicated that both male and female drivers were more likely to be driving a vehicle aged 6 years or older when involved in a serious crash, which is consistent with the Stage 1 report. The vehicle age profile for young drivers involved in serious single-vehicle crashes is similar to when this group of drivers are involved in serious crashes with other road users. The crashworthiness analysis confirmed the results of the Stage 1 report which demonstrated that young drivers were driving vehicles of poorer crashworthiness than older drivers. A chi-square test revealed that a greater proportion of young drivers were driving vehicles of good crashworthiness when involved in serious single-vehicle crashes than when involved in other types of serious crashes. However, despite this, the majority of young drivers involved in serious single-vehicle crashes were driving vehicles in the poor crashworthiness category.

3.3 Urbanisation of Crash Location

3.3.1 What type of crashes are young drivers over-represented?

The third crash characteristic analysed was urbanisation of crash location, which was concerned with identifying patterns in urban and rural crashes for young drivers. Table 15 presents the distribution of urbanisation of crash location by driver age group, separated by sex, for all crash severities. Table 15 shows that in comparison to male drivers aged 25 years or above, male drivers aged 16-17 years and 18-20 years were over-represented in crashes occurring in rural roads. Similarly, female drivers aged 16-17 years or 18-20 years were over-represented in crashes occurring on rural roads in comparison to female drivers aged 25 years or above. Male and female drivers aged 21-24 years were slightly less likely to be involved in a crash on a rural road and therefore slightly over-represented in crashes occurring on metropolitan roads when compared with older drivers.

Table 15: Distribution of the urbanisation of crash locations by driver age and sex for all five jurisdictions and for all crash severities, Australia

Age/sex groups	Metropolitan Area	Rural Area	Total
Male			
16-17	14,908 (71.6%)	5,925 (28.4%)	20,833 (100%)
18-20	49,187 (77.3%)	14,407 (22.7%)	63,594 (100%)
21-24	52,371 (81.2%)	12,156 (18.8%)	64,527 (100%)
25+	344,995 (80.9%)	81,694 (19.1%)	426,689 (100%)
Unknown	13,097 (92.3%)	1,093 (7.7%)	14,190 (100%)
All age	474,558 (80.5%)	115,275 (19.5%)	589,833 (100%)
Female			
16-17	7,882 (69.2%)	3,508 (30.8%)	11,390 (100%)
18-20	32,084 (78.7%)	8,679 (21.3%)	40,763 (100%)
21-24	35,728 (82.8%)	7,435 (17.2%)	43,163 (100%)
25+	229,726 (80.7%)	54,816 (19.3%)	284,542 (100%)
Unknown	6,368 (93.5%)	445 (6.5%)	6,813 (100%)
All age	311,788 (80.6%)	74,883 (19.4%)	386,671 (100%)
Female, Male or Unknown			
16-17	22,816 (70.7%)	9,435 (29.3%)	32,251 (100%)
18-20	81,370 (77.9%)	23,099 (22.1%)	104,469 (100%)
21-24	88,246 (81.8%)	19,609 (18.2%)	107,855 (100%)
25+	628,480 (81.1%)	146,768 (18.9%)	775,248 (100%)
Unknown	21,402 (92.4%)	1,768 (7.6%)	23,170 (100%)
All age	842,314 (80.8%)	200,679 (19.2%)	1,042,993 (100%)

These results could be due to the young driver population shifting away from rural areas in the 18-24 year age group, to gradually return in later years. This is one explanation for why the proportion of crashes involving drivers in the 21-24 year age group that are rural crashes is less than that for mature drivers.

3.3.2 Are the crash types in which young drivers are over-represented more severe than other crash types?

To determine if rural crashes were more severe than crashes occurring in metropolitan areas the proportion of crashes of all severities that were rural crashes was compared to the proportion of serious injury crashes that were rural crashes. As discussed above young drivers aged 16-17 years or 18-20 years were over-represented in crashes occurring on rural roads when compared with drivers aged 25 years or above. Table 16 presents the distribution for the urbanisation of crash location by age group, separated by sex, for serious injury crashes only. It can be seen from Table 16 that 35.4% of serious crashes occurred in rural areas, compared with 15.2% of crashes of all severities. This indicates that crashes on rural roads were more likely to be serious crashes than crashes on metropolitan roads.

Table 16: Distribution of the urbanisation of crash locations by driver age and sex for all five jurisdictions and for all serious injury crashes, Australia

Age/sex groups	Metropolitan Area	Rural Area	Total
Male			
16-17	201 (56.6%)	154 (43.4%)	355 (100%)
18-20	1165 (64%)	654 (36%)	1819 (100%)
21-24	1223 (67.2%)	598 (32.8%)	1821 (100%)
25+	5579 (62.1%)	3398 (37.9%)	8977 (100%)
Unknown	37 (54.4%)	31 (45.6%)	68 (100%)
All age	8205 (62.9%)	4835 (37.1%)	13040 (100%)
Female			
16-17	141 (51.5%)	133 (48.5%)	274 (100%)
18-20	899 (65.1%)	481 (34.9%)	1380 (100%)
21-24	899 (70.5%)	376 (29.5%)	1275 (100%)
25+	4963 (66.9%)	2454 (33.1%)	7417 (100%)
Unknown	16 (50%)	16 (50%)	32 (100%)
All age	6918 (66.7%)	3460 (33.3%)	10378 (100%)
Female, Male or Unknown			
16-17	342 (54.4%)	287 (45.6%)	629 (100%)
18-20	2065 (64.5%)	1136 (35.5%)	3201 (100%)
21-24	2124 (68.6%)	974 (31.4%)	3098 (100%)
25+	10556 (64.3%)	5858 (35.7%)	16414 (100%)
Unknown	54 (53.5%)	47 (46.5%)	101 (100%)
All age	15141 (64.6%)	8302 (35.4%)	23443 (100%)

3.3.3 For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?

Drivers aged 16-17 years or 18-20 years were over-represented in crashes occurring on rural roads, and these crashes were more severe for all ages. To determine if rural road crashes were more severe for young drivers in comparison to drivers aged 25 years or above, the proportion of rural road crashes of all severities were compared to the proportion of serious rural road crashes by driver age group. It can be seen from Table 17 that rural road crashes were less likely to be serious for 16-17 year olds when compared to drivers aged 25 years or older, while rural road crashes involving drivers aged 18 to 24 years were more likely to be serious when compared with drivers aged 25 years or above. In the exploratory analyses reported in Section 3.6, it is shown that the location of the crash is highly correlated with the number of vehicles involved in the crash, with single-vehicle crashes over-represented in rural areas. Specifically, in Australia 70% of crashes in rural areas were single-vehicle crashes. The relative risks of serious injury between different driver age groups for rural crashes shown in Table 17 are very similar to those for single-vehicle crashes shown in Table 12 of Section 3.2.3. As the differences between driver age groups observed in rural crashes actually reflect differences in the involvement in single-vehicle crashes no further analysis will be carried out on the metro/rural crashes.

Table 17: Distribution of crashes occurring on rural roads for males and females separated by serious and all crash severities, Australia

Age	Serious	All	% of crashes that are serious
16-17	287	9435	3.04%
18-20	1136	23099	4.92%
21-24	974	19609	4.97%
25+	5858	146768	3.99%
All ages	8302	200679	4.14%

3.3.4 Summary of findings for urbanisation of crash location

The findings from the urbanisation of crash location indicated that young drivers were over-represented in crashes occurring on rural roads in comparison with drivers aged 25 years or above, with the exception of female drivers aged between 21-24 years. As discussed, this could be due to population movements between metro and rural crashes among the young demographic. Rural crashes were more severe in general when comparing across all driver ages. However when comparing young drivers with drivers aged 25 years or above, rural crashes involving 16-17 year old drivers were less likely to be serious injury crashes when compared to drivers aged 25 years or older, although rural crashes are more likely to be severe for drivers aged 18-24 years when comparing to rural crashes involving drivers aged 25 years or older.

3.4 Road Geometry at Crash Location

3.4.1 What type of crashes are young drivers over-represented?

The fourth crash characteristic analysed was road geometry at the crash location, which was concerned with identifying patterns in intersection and not at intersection crashes for young drivers. Table 18 presents the distribution of road geometry by driver age group, separated by sex, for all crash severities. Overall Table 18 indicates that there is little difference between driver age groups in __ of whether crashes occur at intersections or not. This indicates that young drivers were not over-represented in crashes occurring at intersections or crashes that did not occur at intersections. Therefore for these analyses no further research questions will be explored as the remaining research questions assume that young drivers were over-represented in crashes at particular road geometries.

Table 18: Distribution of the road geometry at the crash location by driver age and sex for all five jurisdictions and for all crash severities, Australia

Age/sex groups	At Intersection	Not At Intersection	Total
Male			
16-17	11,293 (49.6%)	11,495 (50.4%)	22,788 (100%)
18-20	37,531 (49.6%)	38,127 (50.4%)	75,658 (100%)
21-24	38,076 (50.3%)	37,652 (49.7%)	75,728 (100%)
25+	251,686 (52.4%)	228,916 (47.6%)	480,602 (100%)
Unknown	7,038 (53.8%)	6,047 (46.2%)	13,085 (100%)
All age	345,624 (51.8%)	322,237 (48.2%)	667,861 (100%)
Female			
16-17	6,583 (53.5%)	5,715 (46.5%)	12,298 (100%)
18-20	25,796 (53.6%)	22,347 (46.4%)	48,143 (100%)
21-24	26,905 (53.1%)	23,722 (46.9%)	50,627 (100%)
25+	181,078 (56.0%)	142,269 (44.0%)	323,347 (100%)
Unknown	3,349 (55.8%)	2,649 (44.2%)	5,998 (100%)
All age	243,711 (55.3%)	196,702 (44.7%)	440,413 (100%)
Female, Male or Unknown			
16-17	17,891 (51.0%)	17,222 (49.0%)	35,113 (100%)
18-20	63,384 (51.2%)	60,530 (48.8%)	123,914 (100%)
21-24	65,064 (51.4%)	61,454 (48.6%)	126,518 (100%)
25+	453754 (52.1%)	417210 (47.9%)	870964 (100%)
Unknown	11,094 (53.1%)	9,806 (46.9%)	20,900 (100%)
All age	611,187 (51.9%)	566,222 (48.1%)	1,177,409 (100%)

3.5 Road Surface Condition at Crash Location

3.5.1 What type of crashes are young drivers over-represented?

Table 19 presents the distribution of the road surface at the crash location by age group, separated by sex, for all crash severities. Table 19 indicates that, in comparison to males aged 25 years or above, young male drivers were over-represented in crashes occurring on wet road surfaces. Likewise young females were over-represented in crashes occurring on wet road surfaces in comparison to females aged 25 or above.

Table 19: Distribution of the road surface condition at the crash location by driver age and sex for all five jurisdictions and for all crash severities, Australia

Age/sex groups	Wet	Dry	Total
Male			
16-17	4,799 (20.9%)	18,189 (79.1%)	22,988 (100%)
18-20	15,374 (20.2%)	60,557 (79.8%)	75,931 (100%)
21-24	14,406 (18.9%)	61,761 (81.1%)	76,167 (100%)
25+	80,566 (16.7%)	403,082 (83.3%)	483,648 (100%)
Unknown	1,814 (12.6%)	12,538 (87.4%)	14,352 (100%)
All age	116,959 (17.4%)	556,127 (82.6%)	673,086 (100%)
Female			
16-17	2,334 (18.7%)	10,136 (81.3%)	12,470 (100%)
18-20	9,385 (19.4%)	39,007 (80.6%)	48,392 (100%)
21-24	9,549 (18.7%)	41,448 (81.3%)	50,997 (100%)
25+	54,156 (16.6%)	272,671 (83.4%)	326,827 (100%)
Unknown	874 (12.7%)	5,988 (87.3%)	6,862 (100%)
All age	76,298 (17.1%)	369,250 (82.9%)	445,548 (100%)
Female, Male or Unknown			
16-17	7,138 (20.1%)	28,348 (79.9%)	35,486 (100%)
18-20	24,784 (19.9%)	99,649 (80.1%)	124,433 (100%)
21-24	23,980 (18.8%)	103,344 (81.2%)	127,324 (100%)
25+	145,532 (16.5%)	736,489 (83.5%)	882,021 (100%)
Unknown	2,998 (12.8%)	20,399 (87.2%)	23,397 (100%)
All age	204,432 (17.1%)	988,229 (82.9%)	1,192,661 (100%)

More specifically Table 19 shows 20.9% of crashed vehicles driven by a male aged 16-17 years occurred on wet roads, compared with 20.2% for males aged 18-20 years, 18.9% for males aged 21-24 years and 16.7% for males aged 25 years or older. When female drivers aged 16-21 years were involved in crashes, the crashes were more likely to occur on wet roads than when vehicles driven by females aged 25 years or older were involved in crashes. For crashes involving vehicles driven by 16-17 years olds, the crashes were more likely to occur on wet roads when the driver was a male (20.9%) than when the driver was female (18.7%). However, gender-based differences in the distributions diminish for older age groups.

The analysis presented in Table 19 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern as described for young drivers in Australia. Table B19 of Appendix B presents results analogous to Table 19 but for New Zealand crash data.

3.5.2 Are the crash types in which young drivers are over-represented more severe than other crash types?

As discussed above, young drivers were over-represented in crashes occurring on wet road surfaces. To determine if crashes occurring on wet roads were more severe overall, the total proportion of crashes of all severities that occurred on wet road surfaces was compared with the proportion of serious injury crashes that occurred on wet road surfaces. It can be seen that 17.1% of crashes of all severities occurred on wet roads compared with 17.9% of serious injury crashes. This indicates that crashes occurring on wet roads are slightly more severe than crashes on dry roads, however the difference is small. Therefore for analyses of road surface at the crash location, no further research questions will be explored as the remaining research questions assume that not only are young drivers over-represented in certain crash types but that these crash types are more serious overall.

Table 20: Distribution of the road surface condition at the crash location by driver age and sex for all five jurisdictions and for all serious injury crashes, Australia

Age/sex groups	Wet	Dry	Total
Male			
16-17	86 (16.2%)	446 (83.8%)	532 (100%)
18-20	565 (20.8%)	2146 (79.2%)	2711 (100%)
21-24	509 (18.5%)	2242 (81.5%)	2751 (100%)
25+	2277 (16.9%)	11159 (83.1%)	13436 (100%)
Unknown	12 (13.6%)	76 (86.4%)	88 (100%)
All age	3449 (17.7%)	16069 (82.3%)	19518 (100%)
Female			
16-17	77 (19.6%)	315 (80.4%)	392 (100%)
18-20	455 (20.6%)	1751 (79.4%)	2206 (100%)
21-24	388 (19.5%)	1601 (80.5%)	1989 (100%)
25+	2033 (17.4%)	9651 (82.6%)	11684 (100%)
Unknown	5 (13.5%)	32 (86.5%)	37 (100%)
All age	2958 (18.1%)	13350 (81.9%)	16308 (100%)
Female, Male or Unknown			
16-17	163 (17.6%)	761 (82.4%)	924 (100%)
18-20	1020 (20.7%)	3899 (79.3%)	4919 (100%)
21-24	897 (18.9%)	3845 (81.1%)	4742 (100%)
25+	4310 (17.1%)	20843 (82.9%)	25153 (100%)
Unknown	17 (13.5%)	109 (86.5%)	126 (100%)
All age	6407 (17.9%)	29457 (82.1%)	35864 (100%)

The analysis presented in Table 20 was replicated using New Zealand crash data. The pattern of results using New Zealand data was consistent with the pattern as described for young drivers in Australia. The results indicated that crashes occurring on wet roads were slightly more likely to be serious. Specifically, the total proportion of all crashes of all severities occurring on wet roads was 27.1% whereas the total proportion of all serious injury crashes occurring on wet roads was 29.3%. Table B20 of Appendix B presents results analogous to Table 20 but for New Zealand crash data.

3.5.3 Summary of findings for road surface at crash location

The findings from the road surface at crash location analyses indicate that for Australian and New Zealand data, young drivers are over-represented in crashes occurring on wet road surfaces in comparison with drivers aged 25 or above. These crashes were also more severe in general when comparing across all driver ages although the difference is quite small.

3.6 Exploratory Analyses

From the analyses of the five crash characteristics, it was the first two variables (time of day/day of week and crash type) that showed a clear pattern of results. Exploratory analyses were carried out using these variables to investigate how they interacted with each other to increase the risk of young drivers being involved in serious injury crash. The analysis was carried out for young drivers only (aged 16-24 years) and for serious injury crashes only. Table 21 presents a cross-tabulation of crashes by time of day and crash type.

For crashes that occurred on a weekend at night, the results showed that 71.6% were single-vehicle crashes, and for crashes that occurred on a weekday at night 69.1% were single-vehicle crashes, indicating a strong overlap between serious injury night crashes and serious injury single-vehicle crashes among young drivers.

Table 21: Proportion of serious injury crashes by time of day and crash type for young drivers, Australia

Time of Crash	Single-vehicle	Multiple Vehicle	Unprotected Road User	Other	Total
Males					
Weekend Night	1110 (76.3%)	341 (23.4%)	0 (0%)	4 (0.3%)	1455 (100%)
Weekend Day	541 (53.7%)	461 (45.7%)	1 (0.1%)	5 (0.5%)	1008 (100%)
Weekday Night	1067 (74.3%)	367 (25.5%)	1 (0.1%)	2 (0.1%)	1437 (100%)
Weekday Day	962 (44.4%)	1198 (55.2%)	5 (0.2%)	4 (0.2%)	2169 (100%)
Total	3680 (60.6%)	2367 (39%)	7 (0.1%)	15 (0.2%)	6069 (100%)
Females					
Weekend Night	319 (59%)	218 (40.3%)	2 (0.4%)	2 (0.4%)	541 (100%)
Weekend Day	378 (42.6%)	506 (57%)	0 (0%)	3 (0.3%)	887 (100%)
Weekday Night	380 (57.8%)	273 (41.6%)	2 (0.3%)	2 (0.3%)	657 (100%)
Weekday Day	761 (30%)	1768 (69.7%)	1 (0%)	6 (0.2%)	2536 (100%)
Total	1838 (39.8%)	2765 (59.8%)	5 (0.1%)	13 (0.3%)	4621 (100%)
Males, Females or unknown					
Weekend Night	1431 (71.6%)	559 (28%)	2 (0.1%)	6 (0.3%)	1998 (100%)
Weekend Day	920 (48.5%)	967 (51%)	1 (0.1%)	8 (0.4%)	1896 (100%)
Weekday Night	1447 (69.1%)	640 (30.6%)	3 (0.1%)	4 (0.2%)	2094 (100%)
Weekday Day	1724 (36.6%)	2967 (63%)	6 (0.1%)	10 (0.2%)	4707 (100%)
Total	5522 (51.6%)	5133 (48%)	12 (0.1%)	28 (0.3%)	10695 (100%)

The second exploratory analyses investigated the relationship between crashes occurring on rural roads and single-vehicle crashes. In section 3.3.3 it was noted that as the differences between driver age groups observed in rural crashes actually reflect differences in the involvement in single-vehicle crashes, that it was not profitable to distinguish between rural crashes and single-vehicle crashes. The following table presents the degree of overlap of these two variables. It can be seen from Table 22 that single-vehicle crashes were more likely to occur in rural areas, and therefore that it was appropriate to focus on single-vehicle crashes and not crashes occurring on rural roads.

Table 22: Proportion of serious injury crashes by urbanisation of crash location and crash type for young drivers, Australia

Time of Crash	Single-vehicle	Multiple Vehicle	Unprotected Road User	Other	Total
Males					
Metro	1395 (53.3%)	1218 (46.5%)	3 (0.1%)	3 (0.1%)	2619 (100%)
Rural	1073 (74.7%)	356 (24.8%)	1 (0.1%)	6 (0.4%)	1436 (100%)
Total	2468 (60.9%)	1574 (38.8%)	4 (0.1%)	9 (0.2%)	4055 (100%)
Females					
Metro	530 (27.2%)	1415 (72.5%)	3 (0.2%)	4 (0.2%)	1952 (100%)
Rural	658 (65.5%)	341 (33.9%)	1 (0.1%)	5 (0.5%)	1005 (100%)
Total	1188 (40.2%)	1756 (59.4%)	4 (0.1%)	9 (0.3%)	2957 (100%)
Male, Female and unknown					
Metro	1928 (42.1%)	2634 (57.6%)	6 (0.1%)	7 (0.2%)	4575 (100%)
Rural	1732 (70.9%)	697 (28.5%)	2 (0.1%)	11 (0.5%)	2442 (100%)
Total	3660 (52.2%)	3331 (47.5%)	8 (0.1%)	18 (0.3%)	7017 (100%)

3.7 Summary of findings overall

Tables 23 and 24 present the summary of overall findings for each crash analyses of Australia and New Zealand data. The over-represented column specifies where young drivers are over-represented in crashes for each crash characteristic analysed (i.e. the first research question). The severe overall column relates to the second research question of whether the over-represented crash is more severe overall, and the severe 25 years or above represents whether the over-represented crash is more severe in comparison to drivers aged 25 years or above (i.e. the third research question). The vehicle age and crashworthiness columns specify the average vehicle age and crashworthiness category for the particular crash type that was over-represented.

Table 23: Summary of Findings – Australia Data

Over-represented	Severe Overall	Severe c.f. 25+	Vehicle Age	Crashworthiness
Night-time (weekend and weekday)	Yes	No: 16-17 year olds Yes: 18-20/21-24 year olds	6+ years	Poor overall
Single-vehicle	Yes	No: 16-17 year olds No: 18-20/21-24 year olds	6+ years	Poor overall
Rural areas	Yes	No: 16-17 year olds Yes: 18-20/21-24 year olds	N/A	
Wet road surfaces	Yes though slight	N/A	N/A	

NB Young drivers were not found to be over-represented in the analyses of road geometry at crash location (at intersection versus not at intersection) hence this is not reported in Table 23.

Table 24: Summary of Findings - New Zealand Data

Over-represented	Severe Overall	Severe 25+	Vehicle Age	Crashworthiness
Night-time (weekend and weekday)	Yes	No: 16-17 year olds Yes: 18-20/21-24 year olds	6+ years	N/A
Single-vehicle	Yes	No: 16-17 year olds Yes: 18-20/21-24 year olds	6+ years	N/A
Rural areas	N/A	N/A	N/A	N/A
Wet road surfaces	Yes	N/A	N/A	N/A

NB Analyses on crashworthiness, road geometry, urbanisation at crash location were unable to be calculated for New Zealand data

4. DISCUSSION: YOUNG DRIVER CRASH TYPES

4.1 Recapitulation of study aims and data analyses

The aim of this component of the study (Stage 2) was to identify the types of crashes that young drivers were over-represented by comparing the proportion of crashes involving young drivers with experienced drivers. The study aimed to understand the relationship between young drivers' vehicle choice and their crash profile.

In summary, the following four research questions were explored:

1. What type of crashes are young drivers over-represented in comparison to drivers aged 25 or above?
2. Are the crash types in which young drivers are over-represented more severe than other crash types?
3. For the crash types in which young drivers are over-represented, are the crashes involving young drivers more likely to be serious compared to when drivers aged 25 or above are involved in these types of crashes?
4. For crash types in which young drivers are over-represented, what is the distribution of vehicle age and market group of these crashed vehicles?

4.2 Research Findings

The first research question compared young drivers' crash profile with that of drivers aged 25 years or older for all crash severities. The results indicated that young drivers had more crashes occurring at night, more single-vehicle crashes, more crashes in rural areas, and more crashes on wet road surfaces when compared to drivers aged 25 years or older. Similar findings were revealed based on the New Zealand analyses for night-time, single-vehicle and wet road crashes. For all driver age groups there was an even distribution between crashes occurring at intersections versus crashes occurring at non-intersections. Therefore no further analyses were carried out on road geometry.

The results of the first research question indicate that not only do young drivers have more crashes than any other road user group (WHO, 2007) the types of crashes are quite different to that of experienced drivers. However, it may be that the crash types associated with young drivers are less serious overall or that they are less serious when compared to those types of crashes involving experienced drivers. These possibilities were explored in the following two research questions.

With regard to the second research question, the results showed that all the crash characteristics in which young drivers were over-represented were more severe for all driver ages, with the exception of crashes occurring on wet road surfaces – these crashes were only slightly more severe than crashes on dry surfaces and therefore no further analyses were carried out for this crash characteristic. Therefore crashes occurring at night, single-vehicle crashes, and crashes occurring in rural areas were inherently more severe for drivers of any age. This is unfortunate as not only do young drivers have more crashes than other drivers (WHO, 2007), the crashes that they are over-represented in tend to be inherently more severe.

The third research question explored whether the identified over-represented crash types were more likely to be serious when they involved young drivers compared for when they involved drivers aged 25 or above. It was found that for some crash types in which young drivers were over-represented the risk of sever injury varied between age groups. The results showed that when 16-17 year old drivers were involved in a crash occurring at night, or single-vehicle crashes, or crashes on rural roads, they were less likely to be seriously injured in comparison to drivers aged 25 years. This was not the case for drivers aged 18-24 years. For drivers aged 18-24 years, when involved in a crash occurring at night, or single-vehicle crashes, or crashes on rural roads, they were more likely to be seriously injured in comparison to drivers aged 25 years.

The New Zealand analyses revealed slightly different results. For New Zealand drivers aged 16-17 years, when crashing on a weekend at night they were less likely to be seriously injured in comparison with drivers aged 25 years or older, with drivers aged 18-24 years more likely to be seriously injured when crashing during this period when compared to drivers aged 25 years or above. However for crashes occurring on a weekday at night the pattern of results was that 16-17 year old and 18-20 year old drivers were more likely to be seriously injured when crashing at this time (compared with drivers aged 25 years or older), but drivers aged 21-24 years were less likely to be seriously injured when compared with experienced drivers. For the analysis of single-vehicle crashes, all young New Zealand drivers were less likely to be seriously injured in comparison to drivers aged 25 years or older.

The results of the third research question indicate that 16-17 year olds are generally less likely to be seriously injured than older drivers when involved in types of crashes in which young drivers are over-represented (e.g. night-time crashes, single-vehicle crashes). For drivers aged 18-24 years, crashes in which young drivers were over-represented were more likely to result in a serious injury when compared to when drivers aged 25 years or older crash in these situations. Some of the findings associated with crashes occurring in rural areas are probably due to the young rural driver demographic, moving to and from metropolitan centres during the period from their late teens to their early 30s. Other results associated with the increased severity of crashes in rural areas can be explained by the high incidence of single-vehicle crashes in these areas.

The last research question aimed to understand the effect of the vehicle age and vehicle market group of vehicles driven by young drivers when involved in crashes. This involved investigating vehicle age and vehicle market group distributions for serious injury crashes involving young drivers. However, due to the high number of vehicle market groups defined as “Unknown”, analyses on vehicle market group were not carried out. Instead, analyses of vehicle crashworthiness were undertaken. The vehicle profile analysis was carried out for time of crash and road users involved. In both cases the results were consistent with the Stage 1 report. Young drivers were more likely to be driving a vehicle aged 6 years or older when involved in night-time or single-vehicle crashes. This was true for both males and females, for both Australia and New Zealand. The results indicate that the vehicle age profile and crashworthiness profile remain unchanged for crashes occurring in daylight hours, and for crashes involving other road users.

Crashworthiness analyses also showed consistent findings to the Stage 1 report in that young drivers, and in particular young female drivers, were more likely to be driving vehicles with poor crashworthiness in comparison to the proportion of drivers aged 25 years or older. A greater proportion of young drivers involved in serious single-vehicle crashes are driving vehicle with good crashworthiness than young drivers involved in other types of serious crashes, but even so, most young drivers involved in crashes are driving vehicles of poor crashworthiness. This has important implications for vehicle choice optimisation. It appears that vehicle age and the average crashworthiness profile of vehicles driven by young drivers in serious crashes are consistent across time of day of the crash. Vehicle age also appears to be consistent across the number of road users involved.

4.3 Summary of research findings and conclusions

The Stage 1 analyses found that young drivers were more likely to be driving an older vehicle, with young males being more likely to be driving a large vehicle and young females more likely to be driving smaller cars. Stage 2 analyses indicated that the crash profile of young drivers clearly differs from older drivers on time of crash, number of vehicles involved in the crash, location of crash, and road surface at crash location (although only slightly more severe for wet road surface). These crash types are more severe overall with the exception of road surface at crash location.

Many of the crash characteristics associated with increase risk of serious injury pose an even greater risk when the driver was aged 18-24 years when compared to drivers aged 25 years or above. Urbanisation at the crash location was argued to be related to single-vehicle crashes and so analyses of vehicle profile were not carried out for this variable. The results of the vehicle profile analysis indicated that young drivers were more likely to be driving a vehicle aged 6 or more years when crashing at night and for single-vehicle crashes, however, the vehicle age profile remained the same across crashes occurring in daylight hours and crashes involving more than one vehicle. Therefore it is assumed that young drivers' vehicle profile remains unchanged across crash characteristics. Crashworthiness analyses also showed consistent findings to the Stage 1 report in that young drivers, and in particular young female drivers, were more likely to be driving vehicles with poor crashworthiness in comparison to the proportion of drivers aged 25 years or older.

The results of this study are consistent with previous research indicating that the young driver crash profile differs from experienced drivers particularly for night-time crashes and single-vehicle crashes, but also, to a lesser extent for crashes occurring on wet road surfaces (MacDonald et al., 1994). Previous research has indicated that young drivers are more likely to be involved in crashes in urban areas. The results of this study were not consistent with this finding as results showed that young drivers were more likely to be involved in a crash on rural roads relative to the location of crashes involving mature drivers. Consistent with the review of the literature by Ferguson (2003), young drivers in this study were more likely to be driving older vehicles.

In terms of optimising vehicle choice for young drivers, technological solutions in addition to secondary safety performance measures are likely to be beneficial. For example, the finding that young drivers are more likely to be involved in single-vehicle crashes than experienced drivers and that this finding was consistent with previous research (MacDonald, 1994) indicates that technological measures to prevent single-vehicle crashes such as Electronic Stability Control (ESC) are likely to be valuable. ESC in particular could reduce the incidence of single-vehicle crashes among young drivers. This hypothesis requires further research and is explored in Stage 3 of this study.

VEHICLE SAFETY AND YOUNG DRIVERS

STAGE 3: POTENTIAL ROAD TRAUMA BENEFITS OF OPTIMISING YOUNG DRIVER VEHICLE SAFETY

5. INTRODUCTION

The crashworthiness of a vehicle affects injury likelihood in a crash for drivers of all ages, but this is a particularly important consideration for young drivers, who have the highest crash risk of any road user group (OECD, 2006). It is therefore important that young drivers do not drive vehicles that exacerbate their crash risk or provide inferior protection against injuries in the event of a crash. More attention needs to be given to the vehicles young drivers drive, and what buying choices are made when they decide what vehicle type to buy. In considering vehicles that young drivers *should* ideally drive, it should be noted that there can be trade-offs between the protection provided to vehicle occupants and protection to the occupants of vehicles with which they collide. Shifting young drivers from smaller, lighter vehicles to larger, heavier vehicles - which would benefit them in terms of the protection the vehicle provides to them in a crash - may increase injury risk and severity among occupants of other vehicles and other road users with which they collide.

5.1 Summary of Findings From Stages 1 & 2

The key findings from Stages 1 and 2 are listed below:

- Both young female and male drivers were crashing in older vehicles in comparison to their older counterparts;
- Young male crash-involved drivers were driving older vehicles in comparison to their young female counterparts;
- Young female crash-involved drivers were driving smaller vehicles in comparison to older crash-involved drivers;
- The most favoured vehicle market group across all age groups for male crash-involved drivers was Large cars followed by Small cars for young male crash-involved drivers;
- Overall, the crashworthiness of the vehicles favoured by young male and female crash-involved drivers is poorer than older crash-involved drivers even for vehicles of the same age;
- Young drivers were more likely to be involved in single-vehicle crashes and crashes at night in comparison to older drivers. Analyses showed that these crash types were more severe overall, and also more severe for young drivers when compared to drivers aged 25 years or above;
- The results of the vehicle profile analysis showed that young drivers were more likely to be driving a vehicle aged 6 or more years when crashing at night and for single-vehicle crashes, however, the vehicle age profile remains the same across crashes occurring in daylight hours and crashes involving other vehicles. Therefore it was found that young drivers' vehicle profile remains unchanged across crash characteristics suggesting they are driving the same vehicle in all places and times of day; and,
- Crashworthiness analyses showed that young drivers, and in particular young female drivers, were more likely to be driving vehicles with poor crashworthiness in comparison to the proportion of drivers aged 25 years or older for night-time and single-vehicle crashes. For single-vehicle crashes young drivers were over-represented in vehicles with good crashworthiness in comparison to multiple vehicle crashes involving other road users.

5.2 Project Motivation and Aims

Stage 3 of the research program aimed to build upon the outcomes of Stages 1 and 2 by considering the potential for optimising young driver vehicle choice with respect to minimising road trauma outcomes. The research considered a number of scenarios for changing young driver vehicle choice to optimise road trauma outcomes. Some of the scenarios were constrained so that vehicle selections only include vehicles within the same market group or year of manufacture as the vehicles actually driven by young drivers. Other constraints were based on vehicle technologies being present. Road trauma outcomes were calculated primarily from the perspective of changes in the number of young drivers who would have been seriously injured or killed in the period 2001-2005 if young drivers had chosen their vehicles according to the vehicle choice criteria of the scenarios considered. For each scenario, a comparison was made with the observed number of drivers killed or seriously injured during this period. Discussion of the results has considered strategies to optimise vehicle choice among young drivers, paying particular attention to the constraints of purchase price.

6.0 Vehicle Optimisation Scenarios

6.1 Background

The results of Stage 1 demonstrated that young male and female drivers tend to drive vehicles in different market groups. The Stage 2 results demonstrated that whilst young drivers' crash profile was different to that of drivers aged 25 years or above, both young male and young female drivers had a similar crash profile. Young drivers were over-represented in:

1. Single-vehicle crashes
2. Crashes occurring at night (on a weekday or on a weekend).

These two crash types were more severe when compared to drivers aged 25 years or above, and as a result they form the rationale for the vehicle optimisation analysis.

The high rate of serious injury single-vehicle crashes among young drivers can be addressed by focusing on crashworthiness improvements in vehicles driven by this vulnerable age group. The high rate of serious injury night-time crashes among young drivers is more difficult to address purely through vehicle safety optimisation. Currently, the increased crash risk for young drivers at night is addressed through Graduated Driver Licensing Systems by restricting driving during night-time hours. Such night-time driving restrictions are considered to be effective (for a review see Senserrick & Whelan, 2003). Night-time restrictions were introduced in New Zealand in 1987 therefore this law was enforced for the crash database for the years 2001-2005. In Australia the only state to implement a night-time restriction that applies to all novice drivers within a particular phase of the GDLS (e.g. P1) is Western Australia. Western Australia introduced this restriction in 2007, therefore after the 2001-2005 crash database period. There are other states in Australia that have a night-time restriction for young drivers returning from licence disqualification, (e.g. in Queensland and South Australia) however these initiatives were introduced either towards the end of 2005 or in 2007 and thus do not effect the data analysis. The results of Stage 2 of the study are a timely reminder of the importance of night-time driving restrictions in reducing young driver crashes.

There are several considerations to take into account with regard to vehicle choice optimisation. Paine (2002) has pointed out that any measures to discourage the purchase of less safe vehicles may see their price drop, and as a result they may be more accessible to a different category of buyer, for example, young drivers. Demographic statistics indicate that young drivers are the least affluent driver demographic. As a result this group is often restricted to driving a narrower range of vehicles than exist in the fleet as a whole. It has been anticipated that as purchase price and running costs are highly influential, young drivers may drive cars that are older and smaller than average. Such issues will need to be taken into consideration when developing strategies to encourage young drivers to purchase more crashworthy vehicles.

6.2 Scenario Outline

Three scenarios will be considered for optimising young driver vehicle choice:

Scenario 1 will estimate the reduction in crashes if all young drivers were driving:

a) a vehicle with the best crashworthiness rating
b) a vehicle from the ten most-crashworthy vehicles

Scenario 2 will estimate the reduction in crashes if the vehicle the young driver was driving was replaced with a vehicle of the same year of manufacture that was the most-crashworthy vehicle in this year of manufacture. Under this scenario, the most-crashworthy vehicle will either be from:

a) within the same year of manufacture and any vehicle market group

b) within the same year of manufacture and within the same market group

Scenario 3 will estimate the reduction in crashes if all young drivers were driving a vehicle that was equipped with ESC.

The following section explains the methodology employed to compare how each alternative vehicle choice scenario would have increased or decreased the average crashworthiness of vehicles driven by young drivers and the number of young drivers seriously injured or killed or injured over the period 2001-2005.

6.3 Methodology to compare the effects of alternative vehicle choice scenarios

The methodology used to estimate the effect of each vehicle choice scenario on the average crashworthiness ratings of vehicles driven by young drivers and the subsequent effect on the number of young drivers seriously injured or killed was the same for Scenarios 1 and 2. The following section explains the methodology developed for these scenarios and is followed by a short explanation of the method used to estimate the likely effects of Scenario 3.

6.3.1 Scenarios 1 and 2

In order to provide a clear explanation of the methodology used to model the effects of Scenarios 1a, 1b, 2a and 2b, it is necessary to first introduce some notation. The term $\hat{S}_i$ will be used to represent the expected number of young drivers of age group i who would be killed or seriously injured in the period 2001-2005 given young drivers purchased vehicles according to the vehicle choice options specified by Scenarios 1 or 2, while S_i represents the observed number of young drivers of age group i who were actually seriously injured or killed during this period. Similarly, the term $CWR_{i,0}$ represents the average crashworthiness of vehicles actually driven by young drivers of age group i and $CWR_{i,j}$ represents the average crashworthiness of the vehicles driven by young drivers of age group i under vehicle choice scenario j. For example, under scenario 1a, $CWR_{i,1a} = 0.0054$ because the Volkswagen Golf/Jetta manufactured between 2004 and 2006 has the best secondary safety rating of 0.54%.

The expected number of young drivers of age group i seriously injured or killed in the period 2001-2005 if they chose a vehicle according to the conditions of scenario j can then be estimated using the relationship

$$\hat{S}_i = S_i \times \left(CWR_{i,j} / CWR_{i,0} \right). \qquad \text{(Equation 1)}$$

Thus, the expected number of young drivers of age group i killed or seriously injured under scenario j is estimated by multiplying the observed number of serious injuries and fatalities among this group by the ratio of the average crashworthiness rating of vehicles driven by this group under scenario j by the average crashworthiness rating of vehicles actually driven by these young drivers.

This method of estimating the effect of alternative vehicle choice scenarios on the number of seriously injured or killed young drivers is similar to a method used by Newstead & Scully (2009) to estimate the contribution of improvements in secondary safety to changes in the annual count of death and serious injury observed in Australasia in the period 1991-2006. The following section describes how the average crashworthiness of vehicles driven by each young driver group under the baseline, or status quo, scenario was estimated.

6.3.1.1 Estimating average crashworthiness under the baseline scenario

The average crashworthiness rating for each young driver age group under the baseline scenario, $CWR_{i,0}$, was estimated using the point estimates of individual ratings from the 2008 update of the Vehicle Safety Ratings (Newstead, Watson & Cameron, 2008a). Each vehicle in the dataset of police-reported crashes occurring in the period 2001-2005 was assigned a crashworthiness rating. For each vehicle record, the crashworthiness rating was assigned in one of three ways depending on whether a model-specific rating was available. If a model-specific rating was available for a particular record, this rating was assigned to the record. Otherwise, the crashworthiness rating for the vehicle was approximated using the average crashworthiness rating for vehicles of the same market group that were manufactured in the same year. Estimates of the average crashworthiness for different models of vehicles grouped by year of manufacture and market group were available from Newstead, Watson & Cameron (2008a).

Finally, if it was not possible to assign a crashworthiness rating for a record using model-specific ratings and it was not possible to assign ratings using the average ratings of vehicles grouped by year of manufacture and market group, the crashworthiness for the record was estimated based only on the average crashworthiness of vehicles manufactured during the same year. For vehicles crashed in Australia, the average crashworthiness rating of vehicles grouped by year of manufacture was available from the report by Newstead, Watson & Cameron (2008a). The crashworthiness ratings by year of manufacture for vehicles crashed in New Zealand in the period 2001-2005 were taken from the supplement to the 2008 update of the Used Car Safety Ratings Report (Newstead, Watson & Cameron, 2008b). As explained by Newstead, Watson & Cameron (2008b) crashworthiness by year of manufacture estimates were estimated separately for Australia and New Zealand because trends in vehicle crashworthiness by year of manufacture depend on the composition of the vehicle fleet and the Australian and New Zealand fleet differ with respect to vehicle mix, partly because New Zealand have a program of importing used vehicles from overseas.

It was also necessary to adjust Newstead, Watson & Cameron's (2008b) crashworthiness by year of manufacture ratings for New Zealand vehicles so that the New Zealand estimates could be directly compared to estimates derived for Australian vehicles. As explained by Newstead, Watson & Cameron (2008b), the crashworthiness by year of manufacture ratings for the Australian fleet were estimated using data from police-reported crashes, which included crashes that did not result in injury. However the New Zealand crashworthiness by year of manufacture ratings were derived only using data from crashes that results in injury, because the reporting coverage of non-injury crashes in New Zealand is not clear. Therefore, the New Zealand crashworthiness estimates reported by Newstead, Watson & Cameron (2008b) for vehicles of a particular year of manufacture represent the risk that a driver of a vehicle manufactured in a particular year is seriously injured given the driver of the vehicle that they collided with was also injured. By comparison, the crashworthiness by year of manufacture ratings derived by Newstead, Watson & Cameron (2008a) for Australia represent the risk that the driver of the vehicle manufactured in the particular year is seriously injured when involved in a police-reported crash, irrespective of the injury status of other road users involved in the crash. This meant that crashworthiness ratings by year of manufacture for New Zealand vehicles were greater than that of derived for comparable years using Australian data (see Figure 2) as the sample of crashes used to derive New Zealand estimates was on average more severe than that used to derive the Australian estimates of crashworthiness by year of manufacture. Therefore, although the crashworthiness by year of manufacture ratings derived by Newstead, Watson & Cameron (2008b) are effective in representing relative changes in crashworthiness with respect to year of manufacture within the New Zealand fleet, they must be adjusted before they can be used to compare the crashworthiness by year of manufacture trends in New Zealand with those in Australia.

There are numerous ways in which such an adjustment can be made. In this study, it was assumed that the average level of secondary safety of late-model vehicles driven in New Zealand would be similar to that for recently manufactured vehicles driven in the Australian fleet. This assumption is likely to be true because the secondary safety standards of new vehicles available for purchase in New Zealand are similar to that of new vehicles available in Australia. New Zealand's used import program will have minimal effect on the average crashworthiness by year of manufacture estimate for recently manufactured vehicles. Therefore, as the crashworthiness by year of manufacture trends offer a good indication of the relative differences in crashworthiness by year of manufacture within the New Zealand fleet, estimates for New Zealand vehicles can be scaled to estimates for the Australian fleet by shifting the New Zealand year of manufacture estimates by the difference between Australian and New Zealand crashworthiness estimates for vehicles belonging to a recent model year.

However it is also necessary for the adjustment described in the previous paragraph to take into account differences in the risk of serious injury between the two jurisdictions. It is likely that the risk of serious injury given involvement in a crash is greater for New Zealand than Australia because a greater proportion of crashes in New Zealand are single-vehicle crashes occurring in rural areas and these types of crashes are more likely to have severe injury outcomes. For example, from Table 10, 18% of crashes in Australia were single-vehicle crashes compared with 22% of crashes in New Zealand (from Table B10 in Appendix B). However, it is difficult to quantify the difference in the risk of serious injury between Australia and New Zealand because of differences in how serious injuries are reported between the two jurisdictions. Therefore, for the purposes of this study, the difference between Australia and New Zealand in the risk of a driver being killed per 100,000 registered vehicles was used to account for differences in overall serious injury risk between the two countries. Using the Used Car Safety Rating data for crashes occurring in 2004 and registration counts available from the Australian Bureau of Statistics (2005) and the New Zealand Ministry of Transport's website (http://www.transport.govt.nz/research/Pages/annual-statistics-2005.aspx), it was found that 5.61 drivers were killed per 100,000 passenger vehicle registrations in Australia, compared with 6.95 for New Zealand. Therefore the ratio of driver fatalities per 100,000 driver registrations for New Zealand compared to Australia was approximately 1.24:1. Multiplying the estimate of the average crashworthiness of cars manufactured in 2004 for Australia by 1.24 gives an estimate of the risk of serious injury for New Zealand drivers of vehicles manufactured in 2004 that is not biased by the lack of reliable non-injury data in New Zealand.

Newstead, Watson & Cameron (2008a) estimated that the average crashworthiness of vehicles manufactured in 2004 in the Australian fleet was 2.24%. Multiplying by 1.24 gives an estimate of 2.78% for the risk of serious injury for New Zealand drivers of vehicles manufactured in 2004. Newstead, Watson & Cameron (2008b) estimated that the average crashworthiness of 2004 model vehicles in the New Zealand fleet was 4.20%, which is approximately 1.4 percentage points higher than the corrected estimate of 2.78%. Lowering Newstead, Watson & Cameron's (2008b) New Zealand crashworthiness estimate for each year of manufacture category by 1.4 percentage points will give an estimate of crashworthiness by year of manufacture that can be compared with analogous estimates derived using Australian data. These corrected estimates are presented as yellow data points in Figure 2.

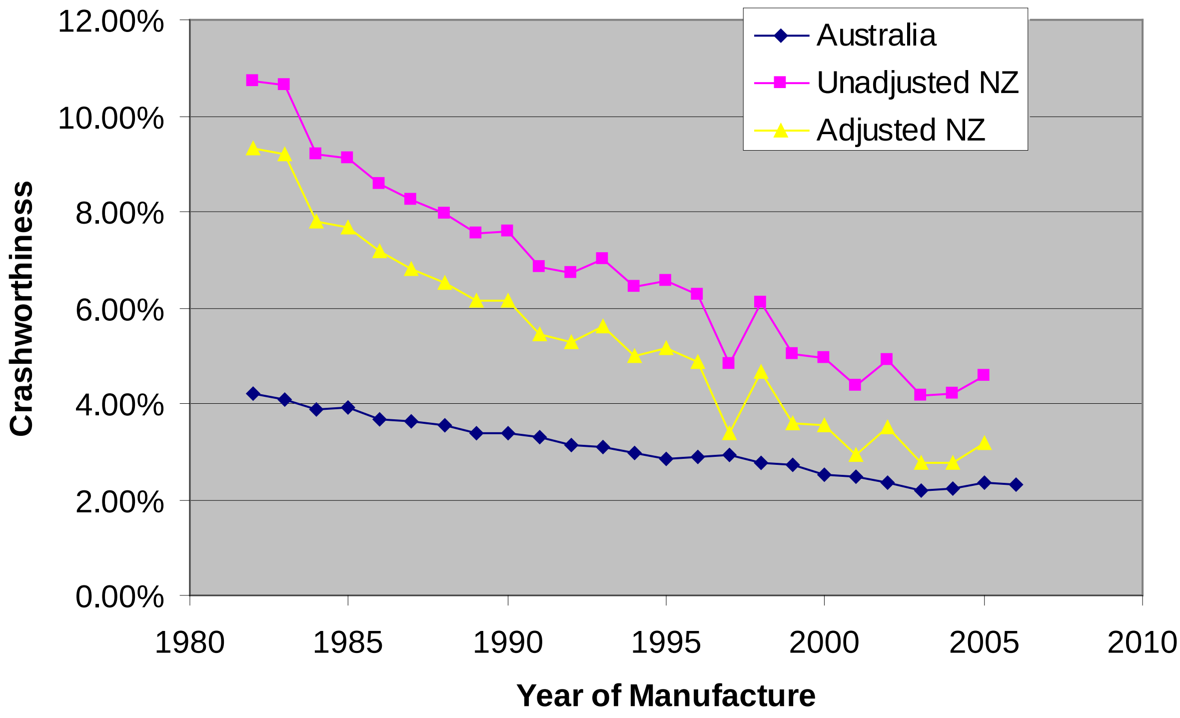

Figure 2: Average crashworthiness of vehicles crashed by young drivers by year of manufacture for Australia, New Zealand (unadjusted) and New Zealand where adjustments have been made to account for the unavailability of reliable non-injury crash data

6.3.2 Scenario 3

Scenario 3 involved young drivers only driving vehicles that were fitted with Electronic Stability Control (ESC). In order to estimate the number of serious injuries and fatalities involving young drivers if all their vehicles were fitted with ESC, it is necessary to work out the extent to which fitting all vehicles with ESC would reduce the risk of a crash that resulted in drivers being seriously injured or killed. Multiplying this estimated reduction in risk by the number of serious injuries and fatalities in each driver age group observed under the baseline scenario will give the expected number of serious injuries and fatalities if all vehicles were fitted with ESC.

Based on the results of Scully & Newstead (2008), it was assumed that ESC has no affect on the risk of multiple vehicle crashes and reduces the risk of single-vehicle crashes by approximately 32%. Table 25 describes the process used to estimate how applying Scenario 3 would reduce the risk of serious injury or death for young drivers in Australia, while Table 26 shows the analogous process for young drivers in New Zealand. As can be seen from the tables, as well as using estimates of the effectiveness of ESC in reducing the risk of serious single-vehicle crashes, the percentage of serious crashes that were single-vehicle crashes and the percentage of vehicles that were already fitted with ESC were used to estimate the effect of fitting ESC for each young driver age group.

Table 25: Calculation of Scenario 3 estimating the effect of fitting vehicles driven by young drivers with ESC (Australia)

	% Vehicles fitted with ESC			% Crashes SVC	Reduction in SVC	Reduction in Crash Risk
	Scenario 3	Baseline Scenario	Scenario 3 - Baseline			
16-17 years	100%	– 0.20%	= 99.800%	× 62.40%	× 32.36%	= 20.15%
18-20 years	100%	– 0.20%	= 99.800%	× 51.80%	× 32.36%	= 16.73%
21-24 years	100%	– 0.30%	= 99.700%	× 49.20%	× 32.36%	= 15.87%

The estimates of the reduction in risk associated with the requirement that all young drivers drive vehicles fitted with ESC are shown in the right-most column of Table 25 and Table 26 for Australia and New Zealand respectively. These estimates of reduction in crash risk have been used in Section 6.4.3 to estimate what proportion of the observed number of cases of young drivers being seriously injured or killed could have been prevented under Scenario 3.

Table 26: Calculation of Scenario 3 estimating the effect of fitting vehicles driven by young drivers with ESC (New Zealand)

	% Vehicles fitted with ESC			% Crashes SVC	Reduction in SVC	Reduction in Crash Risk
	Scenario 3	Baseline Scenario	Scenario 3 - Baseline			
16-17 years	100%	– 0.20%	= 99.800%	× 54.20%	× 32.36%	= 17.50%
18-20 years	100%	– 0.20%	= 99.800%	× 56.30%	× 32.36%	= 24.31%
21-24 years	100%	– 0.30%	= 99.700%	× 54.30%	× 32.36%	= 17.52%

6.4 The effect of alternative vehicle choice scenarios on the number of young drivers killed or seriously injured

This section describes what how the estimated number of young drivers killed or seriously injured would have changed had young drivers been driving vehicles that were obtained under the vehicle choice requirements described by Scenarios 1, 2 and 3. The expected number of young drivers in each age category who would have been killed or seriously injured in the period 2001-2005 under each alternative vehicle choice scenario is compared to the number observed under the baseline or status quo scenario. Estimates of the number of young drivers killed or seriously injured under the baseline scenario are taken from Stage 2 of the report which was derived using data from five Australian jurisdictions and New Zealand.

6.4.1 Scenario 1

Scenario 1 was the most general of all the scenarios. This scenario estimated the reduction in crashes given that young drivers were driving either the vehicle with the best crashworthiness (Scenario 1a), or, a vehicle from the average crashworthiness rating from the top ten most-crashworthy vehicles (Scenario 1b).

Scenario 1a

Under this scenario, all young drivers drove a vehicle with a crashworthiness rating equal to the crashworthiness of the vehicle that was found to offer the best occupant protection. Newstead, Watson & Cameron (2008a) found that the most-crashworthy vehicle had a rating of 0.54% (a Volkswagen Golf/Jetta manufactured between 2004-2006). Therefore, the average crashworthiness value of vehicles driven under Scenario 1a was 0.54%.

Figure 3 and Figure 4 display the average crashworthiness ratings at baseline and following treatment of Scenario 1a for Australia and New Zealand respectively. The data show that the baseline crashworthiness rating for all young drivers was between 3.7% and 3.9% for Australian data and 4.9% and 5.4% for New Zealand data.

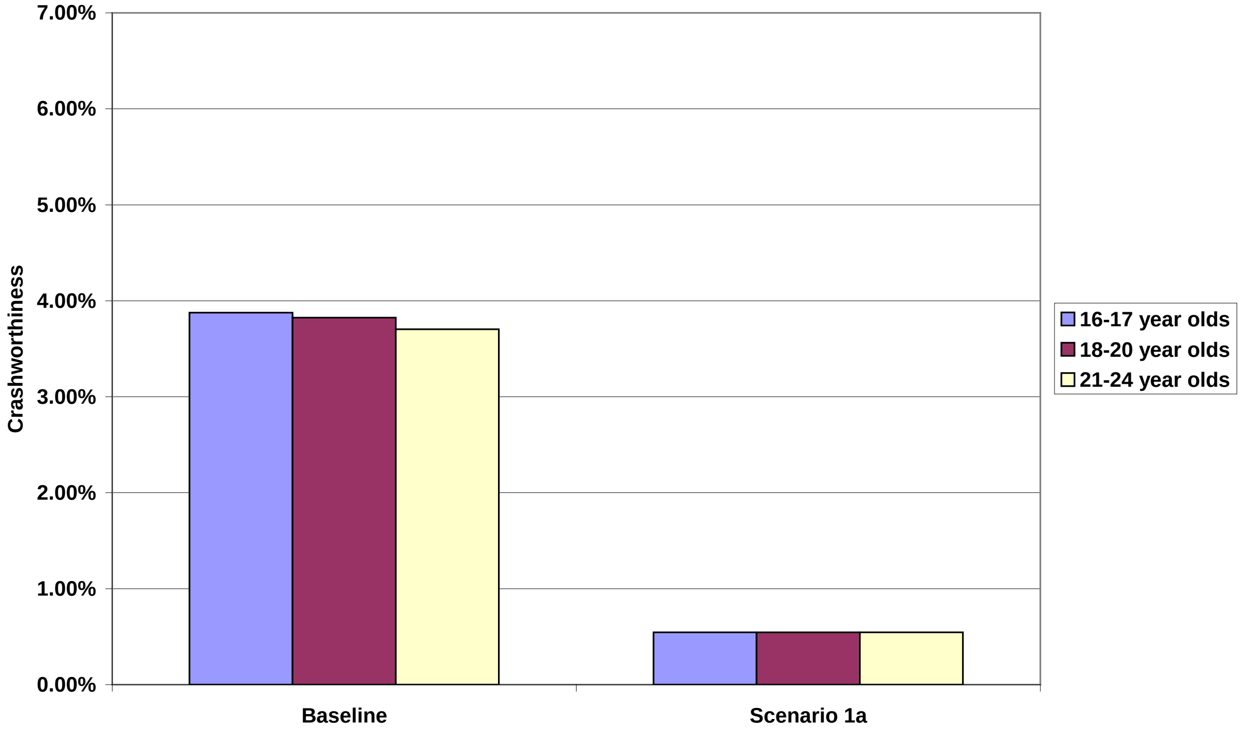

Figure 3 Comparison of average crashworthiness ratings for young driver age groups at baseline and following Scenario 1a treatment (Australia)

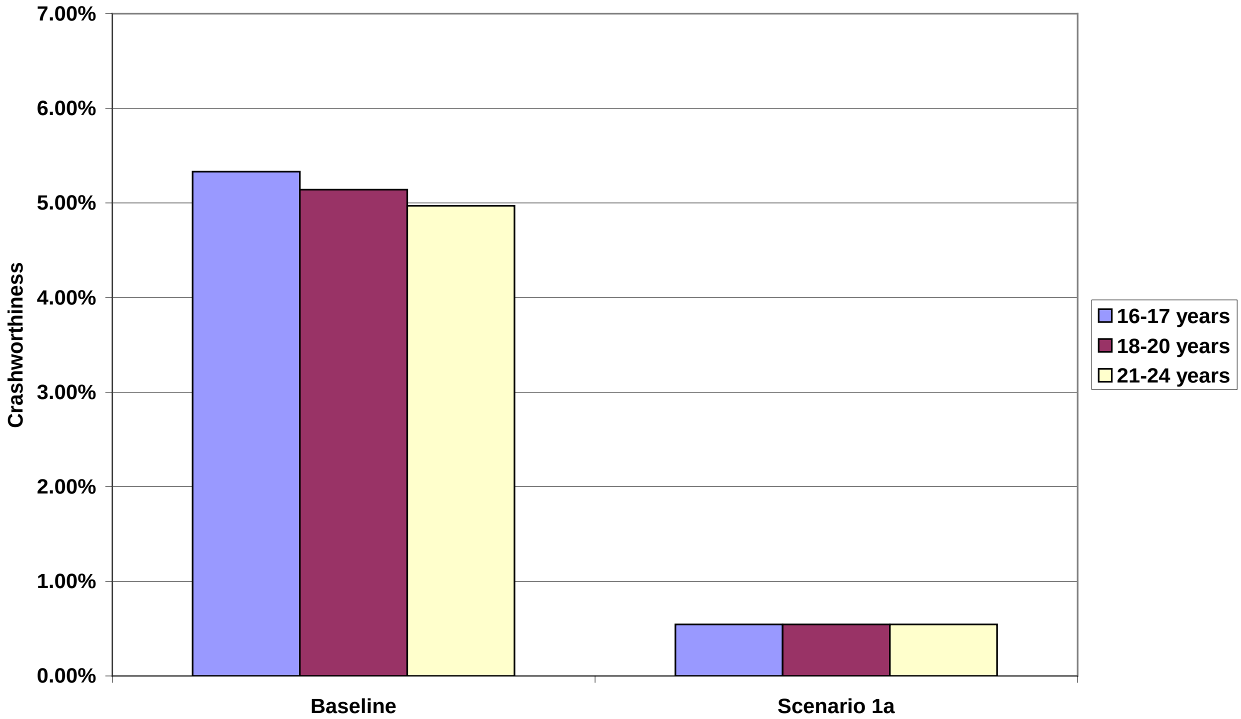

Figure 4 Comparison of average crashworthiness ratings for young driver age groups at baseline and following Scenario 1a treatment (New Zealand)

Substituting the average baseline and Scenario 1a crashworthiness estimates shown in Figure 3 and Figure 4 into Equation 1 of Section 6.3.1 gives the effect on the number of serious injuries and fatalities among young drivers in the period 2001-2005 if all young drivers were driving the most-crashworthy vehicle available during this period. It can be seen from Figure 5 and Figure 6 that in terms of the number of serious injuries and fatalities prevented, there would be a reduction in serious injuries and fatalities in all three young driver age groups. For example, it is estimated that Australian drivers aged 18 to 20 years who were seriously injured or killed in the period 2001-2005 would fall from 4,948 to approximately 705 in Scenario 1a had have been adopted. For 21 to 24 year olds the number of serious injury crashes would be estimated to reduce from 4,780 to approximately 704. Similarly, for New Zealand drivers aged 18 to 20 years the number of young drivers seriously injured or killed would fall from 826 to 88 in the period 2001-2005 if Scenario 1a had have been adopted.

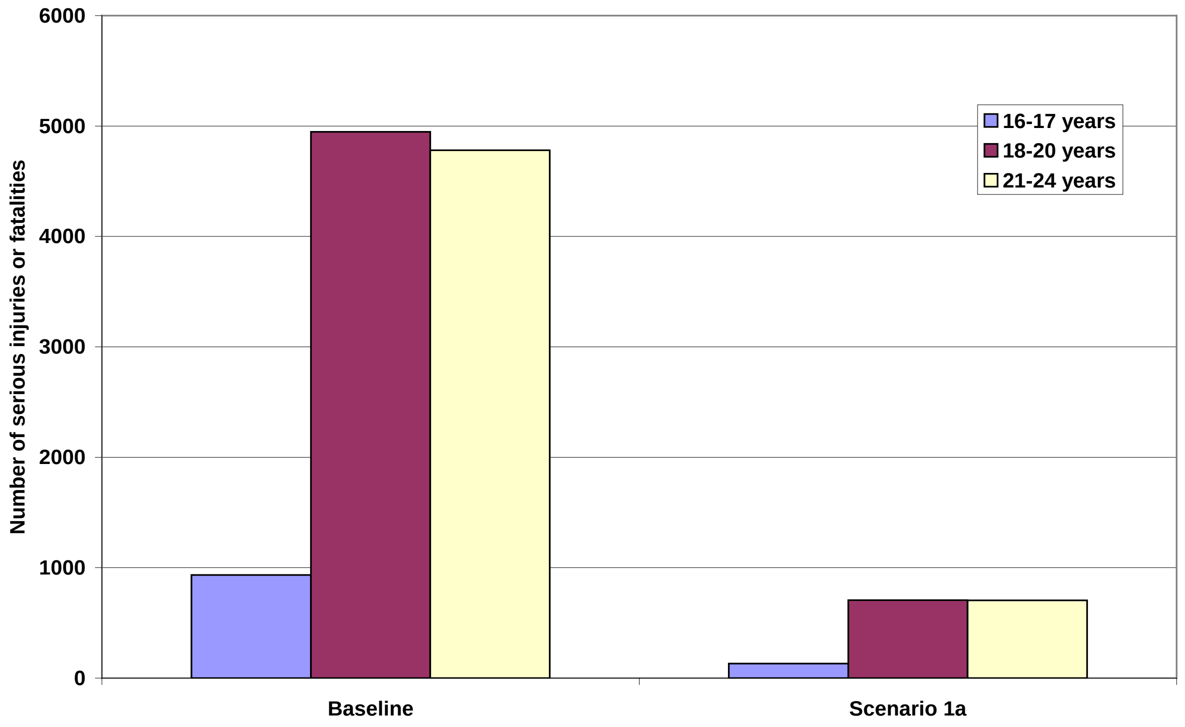

Figure 5 Comparison of serious injury crash rates for baseline and following Scenario 1a treatment (Australia)

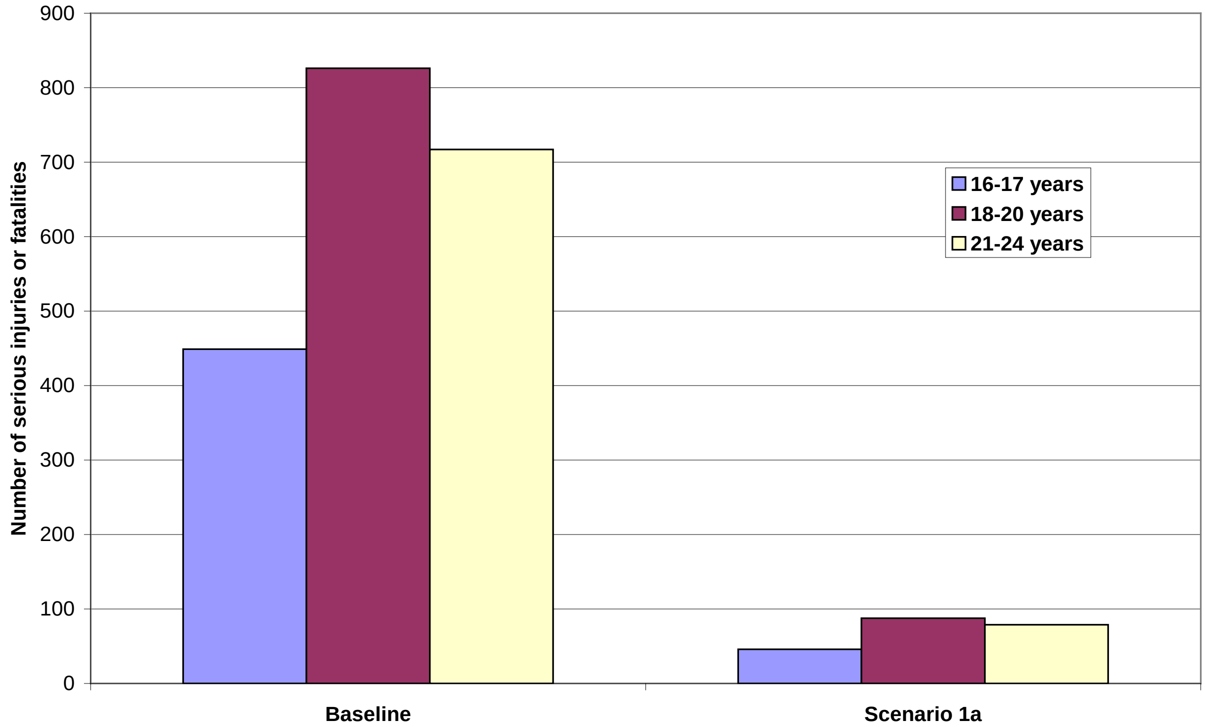

Figure 6 Comparison of serious injury crash rates for baseline and following Scenario 1a treatment (New Zealand)

Scenario 1b

Scenario 1a was based on young drivers driving the safest vehicle. This was a best-case scenario, which did not consider practical implications. That is, until there are more vehicles manufactured with similar crashworthiness ratings as the Volkswagen Golf (0.54%), it cannot be expected that all young drivers will be able to drive these vehicles as the purchase price is relatively high. So, a more realistic scenario was developed, whereby the crashworthiness values of the top ten most-crashworthy models were averaged (Scenario 1b). Only crashworthiness values of vehicles manufactured between 1982 and 2006 were included in the list of the ten most-crashworthy vehicles. The average crashworthiness for the top ten models was 1.02%. This is almost double the crashworthy rating assumed under Scenario 1a. Table 27 lists the ten vehicles identified as being the most-crashworthy. The Renault Scenic is also included in this list but was not included in the analysis as the 90% confidence interval for this model overlapped the all model crashworthiness rating. This meant that the Renault's rating was not statistically significantly superior to the average rating among all models. Therefore there are 10 models shown in Table 27 plus the Renault Scenic model.

Figure 7 and Figure 8 provide a comparison of the effectiveness for Scenarios 1a and 1b for Australia and New Zealand respectively. Both figures indicate that Scenario 1a was the most effective in terms of the number of serious injuries and fatalities prevented.

Table 27: Rank of top ten most-crashworthy models

Rank	Make	Model	Years Manufactured	Market Group	Crashworthiness (%)
1	Volkswagen	Golf / Jetta	04-06	Small	0.545649981
2	Kia	Carnival	99-06	People Mover	0.931871257
3	Hyundai	Grandeur	99-00	Large	0.950613878
4	Volkswagen	New Beetle	00-06	Small	0.995732305
5	Mazda	MPV	93-99	People Mover	0.998883644
6	Ford	Explorer	01-05	4WD - Large	1.017001014
7	*Renault*	*Scenic*	*01-05*	*Small*	*1.074004839*
8	Mercedes Benz	M-Class W163	98-05	4WD - Large	1.14876088
9	BMW	7 Series E38	95-01	Large	1.195567308
10	Peugeot	406	96-04	Medium	1.21417358
11	Lexus	IS200 / IS300	99-04	Medium	1.29209425

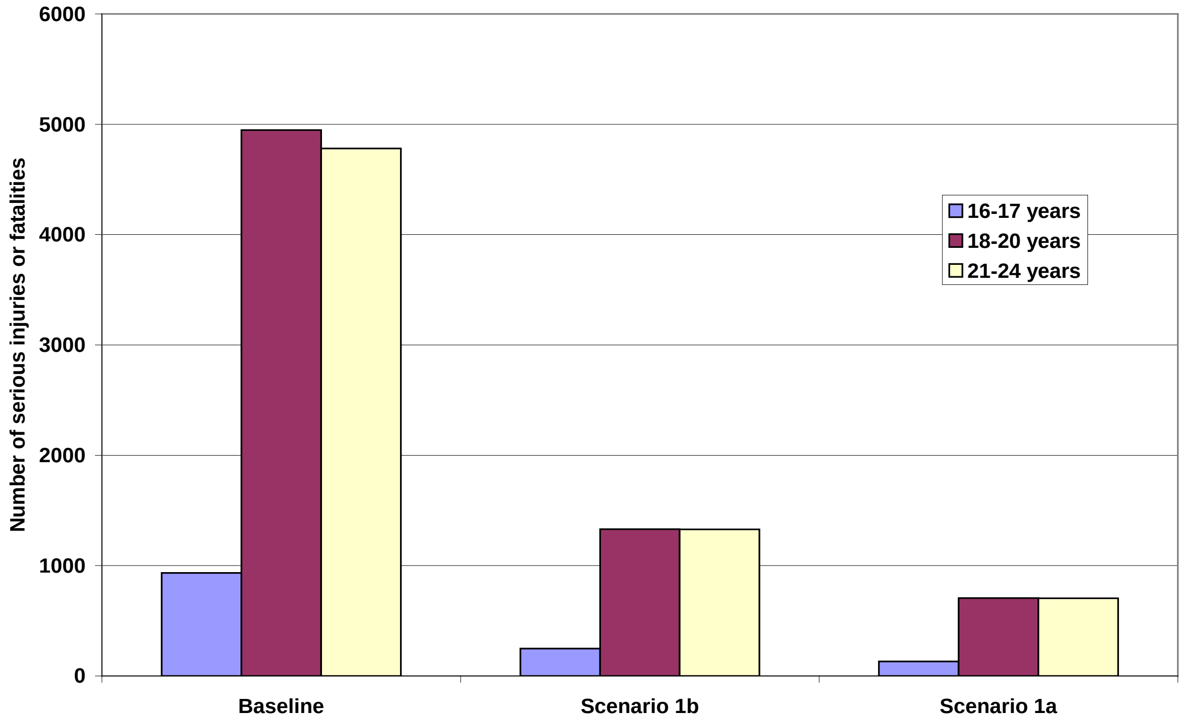

Figure 7 Comparison of reductions in serious injury and fatal crashes from baseline following treatments in Scenario 1b and 1a (Australia)

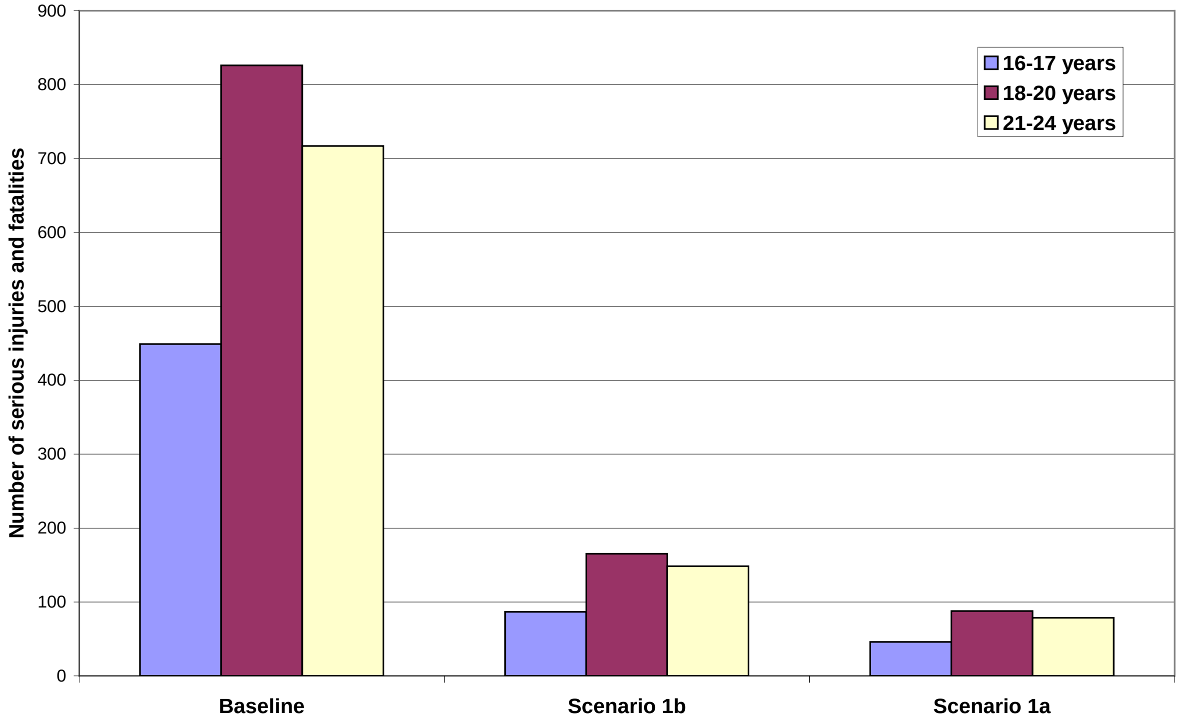

Figure 8 Comparison of reductions in serious injury and fatal crashes from baseline following treatments in Scenario 1b and 1a (New Zealand)

6.4.2 Scenario 2

Scenario 2 consisted of two components (2a and 2b). Under Scenario 2, young drivers were assumed to be driving the safest vehicle available within certain constraints. Specifically, under Scenario 2a, young drivers were assumed to be driving a vehicle manufactured in the same year as the vehicle that they were driving under the baseline scenario except that it was assumed that the vehicle they were driving under scenario 2a was the safest model manufactured in the particular year.

Under Scenario 2b, an additional constraint was added: that in addition to driving a vehicle manufactured in the same year as the vehicle the young driver was driving when the crash occurred it was also assumed that the young driver was driving a vehicle of the same market category. It was also assumed that the young driver was driving the safest vehicle available within the relevant subset of vehicles defined by their own vehicle's market group and year of manufacture. Thus, if a record for a seriously injured or killed young driver indicated they were driving a 1994 large car when they crashed their vehicle, under Scenario 2b it was assumed that the young driver was driving the model of large car that had the best crashworthiness rating of all large cars manufactured in 1994.

Therefore, whilst Scenario 2a did not specify the vehicle market group, Scenario 2b specified the same year of manufacture and same market group as the vehicle in which the young driver crashed. The most-crashworthy model within each year of manufacture (and market group) category was defined as the vehicle with the lowest crashworthiness rating for the particular year for which the upper 90% confidence interval of the crashworthiness estimate was not greater than the average all model crashworthiness (3.68%).

Scenario 2a

Figure 9 shows models of vehicles identified as being the most-crashworthy within each year of manufacture. It can be seen from Figure 9 that there were six different types of vehicles overall, with crashworthiness ratings ranging from 2.49% (1982/1983 Peugeot 506) to 0.54% (2004-2006 Volkswagen Golf/Jetta).

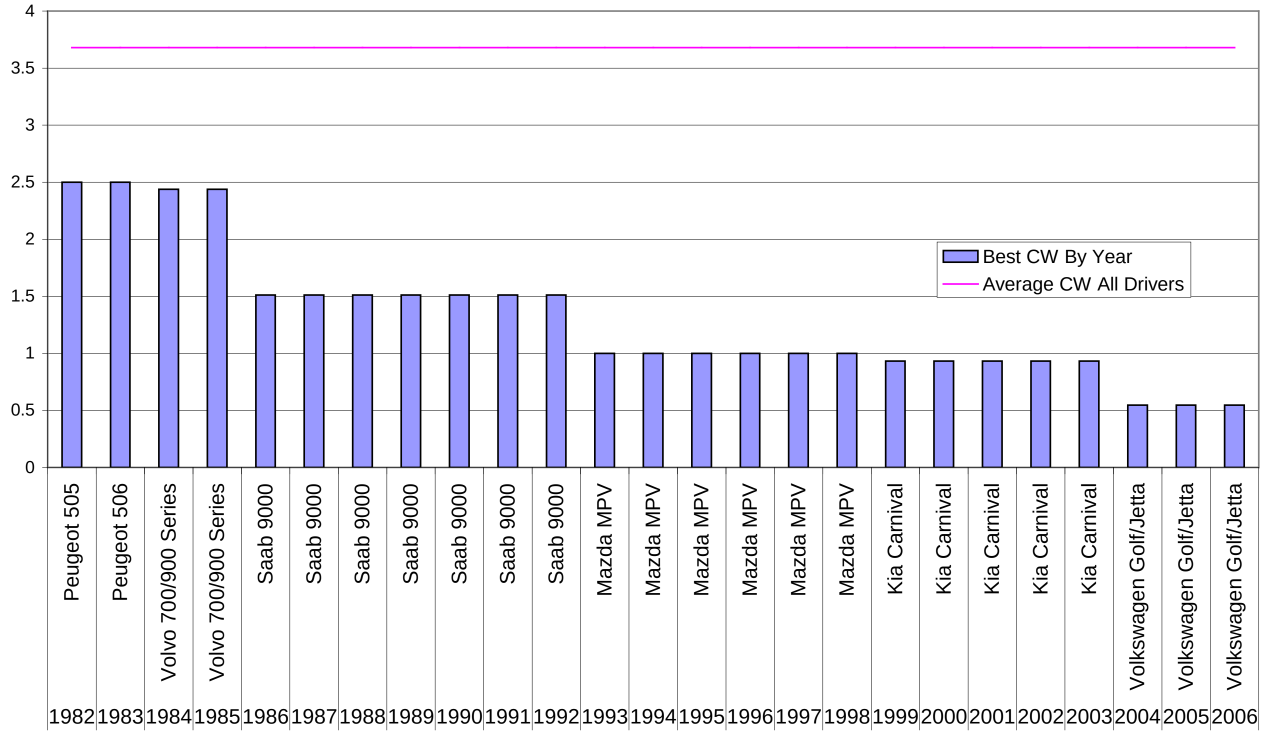

Figure 9: Most crashworthy vehicle by year of manufacture and average crashworthiness rating for all drivers

Figure 10 and Figure 11indicate that under Scenario 2a, there would be a reduction in serious injuries and fatalities for each of the three young driver age groups. That is, for Australia (see Figure 10), the number of 18 to 20 year olds seriously injured or killed is estimated to fall from 4,948 to 1,790, and for 21-24 year olds from 4,780 to approximately 1,664. For the youngest age group (16 -17 years), the number of drivers seriously injured or killed in Australia would fall from 933 to 349.

From Figure 11 it can be seen that the number of young drivers killed or seriously injured in New Zealand would fall from 449 to 130 for 16 to 17 year olds, from 826 to 236 for 18-20 year olds and from 717 to 204 for 21-24 year olds.

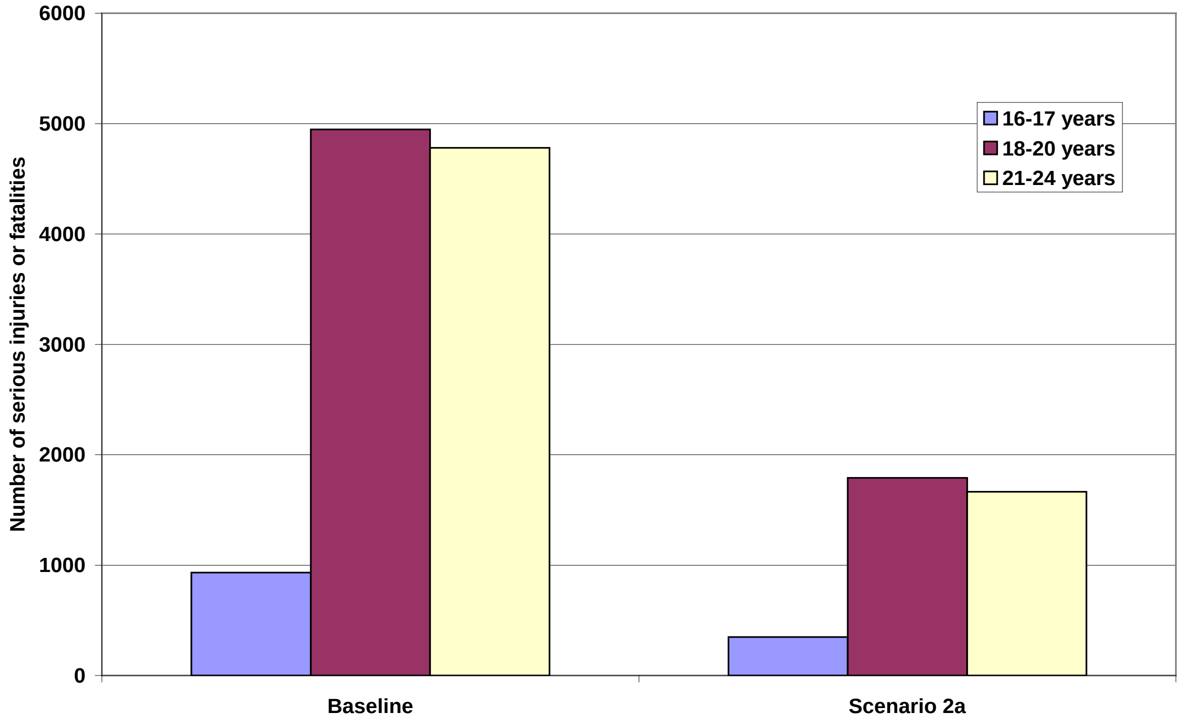

Figure 10 Comparison of reductions in serious injury and fatal crashes from baseline following treatment from Scenario 2a (Australia)

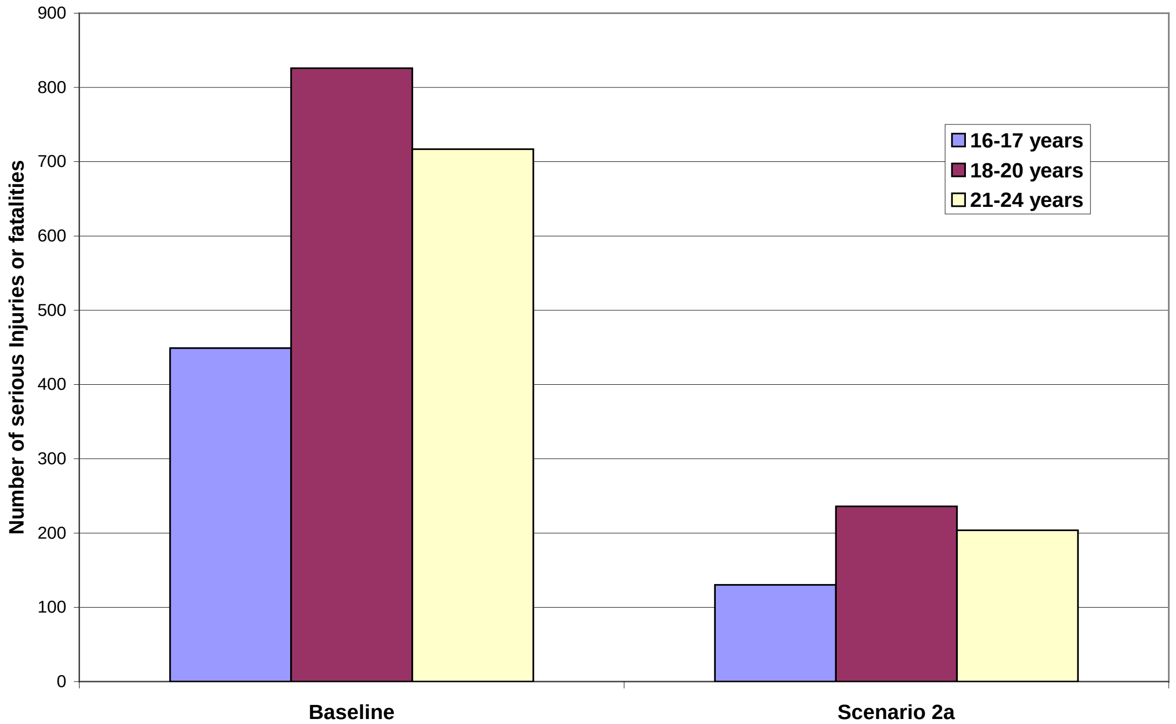

Figure 11 Comparison of reductions in serious injury and fatal crashes from baseline following treatment from Scenario 2a (New Zealand)

Scenario 2b

As an example of how Scenario 2b would affect what car a young driver is assumed to be driving, for a data record that states that a young driver was driving a small car manufactured in 2000, under Scenario 2b, it would be assumed that the driver would be driving the most-crashworthy small vehicle manufactured in 2000 (i.e. Volkswagen New Beetle).

It is important to note that if a vehicle of a particular market group or model was not significantly more crashworthy than the average (3.68%) no recommendations were made on what vehicle should be purchased. This is because it would be inappropriate to recommend that a young driver purchase a vehicle that is potentially less safe than the average vehicle purely because the young driver wishes to purchase a vehicle of a particular market group.

In addition, there is the issue that some market groups should be avoided by young drivers altogether. Such market groups include sports cars and 4WDs. It is not appropriate to encourage young drivers to drive sports cars or 4WDs by recommending some types of sports cars or 4WDs over others. Such a recommendation could be interpreted as suggesting to young drivers that sports cars or 4WDs can be a good choice, while in fact research suggests that these types of vehicles are not appropriate choices for young drivers. A better strategy would be to encourage young drivers to avoid sports cars and 4WDs altogether.

The following figures display the most-crashworthy vehicles by year of manufacture for each vehicle market group. Figure 12 indicates that until 1994 there were no Compact 4WD vehicles manufactured that were below the average crashworthiness of 3.68%. From 1994 to 1996 the Toyota RAV4 was deemed the most-crashworthy Compact 4WD, while from 1997 to 2001, the Honda CR-V (manufactured from 1997-2001) was found to be the most-crashworthy Compact 4WD. Finally, from 2002-2006, the next edition of the Honda CR-V was found to be the most-crashworthy Compact 4WD. The crashworthiness of each of these models ranged from 1.78% to 3.02%.

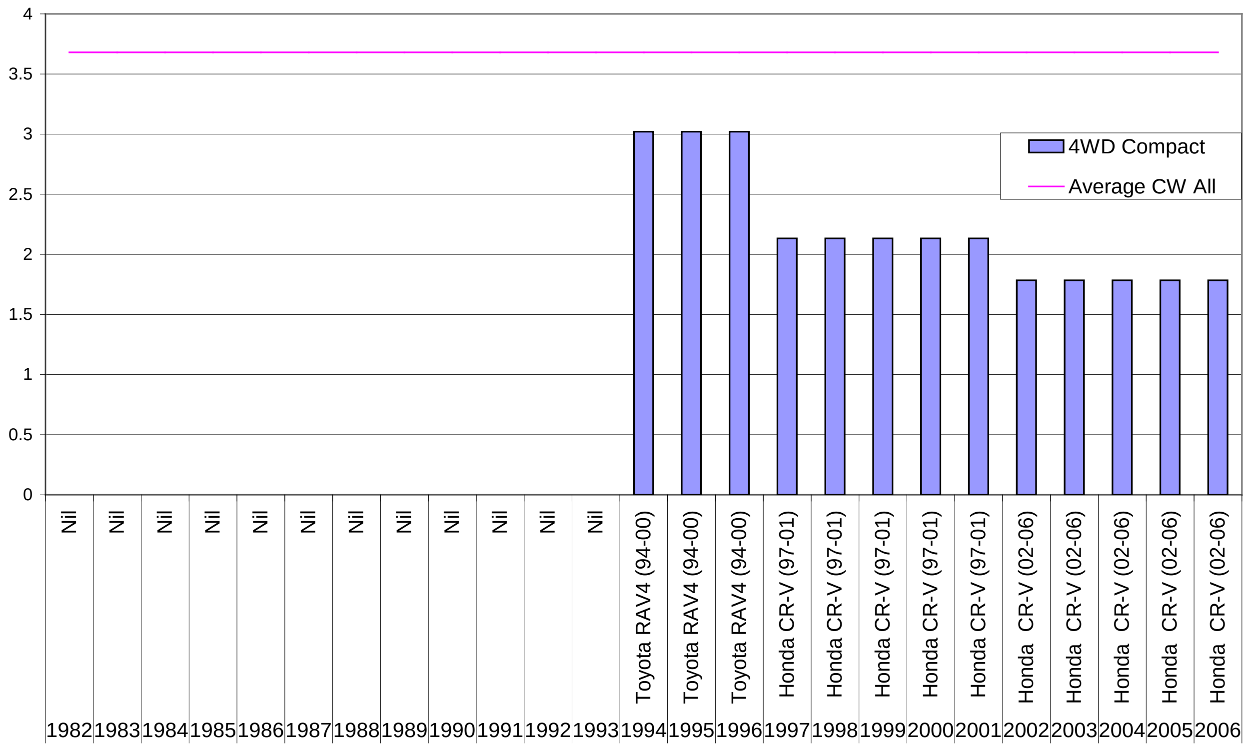

Figure 12 Most-crashworthy 4WD Compact by year of manufacture

Figure 13 indicates that there were six different Large 4WD vehicles that had a crashworthiness rating below the average crashworthiness of 3.68%. For the six models the crashworthiness ratings ranged from 1.02% to 2.70%.

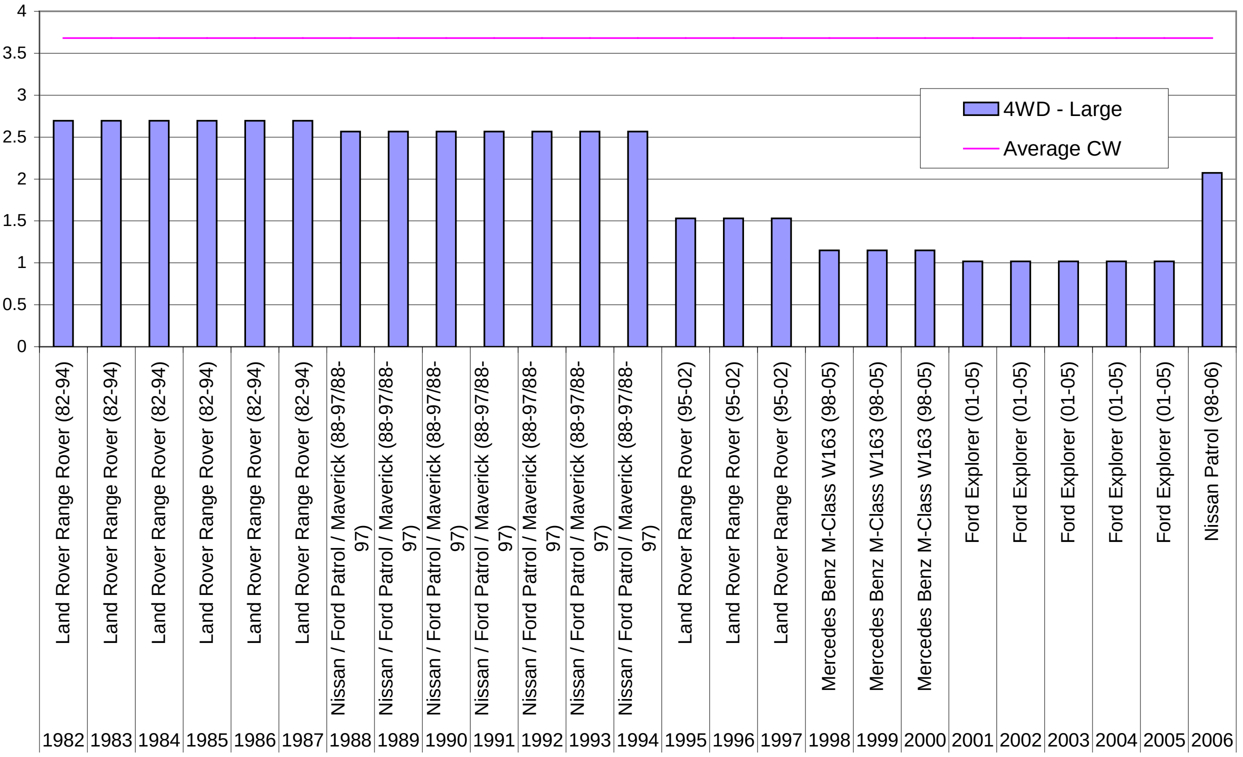

Figure 13 Most-crashworthy 4WD Large by year of manufacture

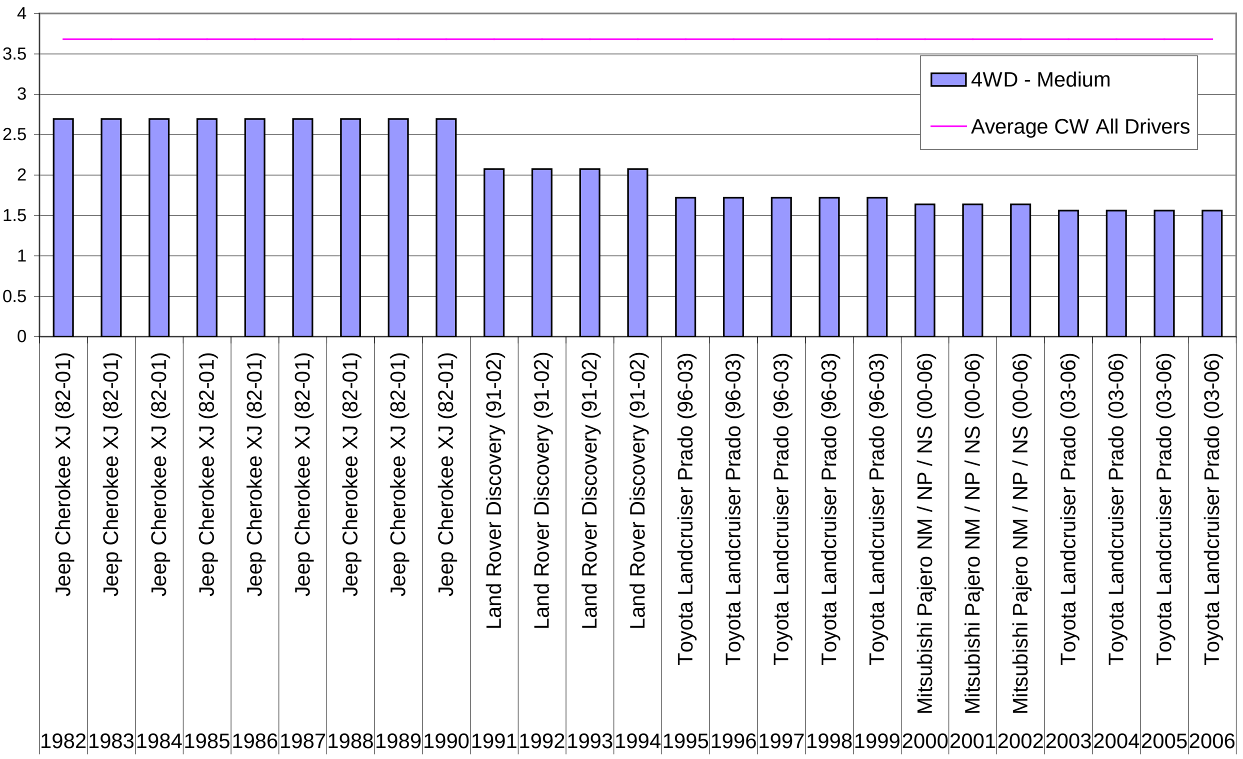

Figure 14 Most-crashworthy 4WD Medium by year of manufacture

Figure 14 shows the most-crashworthy medium 4WDs by year of manufacture. It can be seen that the crashworthiness ratings of the best medium 4WDs ranged from 1.56% to 2.69%. The crashworthiness of newer models was better than that of the best performers from previous years. For Commercial Utes (Figure 15) three different models were identified as being the most-crashworthy ute in the year that they were manufactured. For the three models displayed in Figure 15 the crashworthiness ratings ranged from 1.77% to 2.58%. No Commercial Utes manufactured between 1993 and 1995 had crashworthiness ratings that were significantly (p<0.1) less than the average rating of 3.68%.

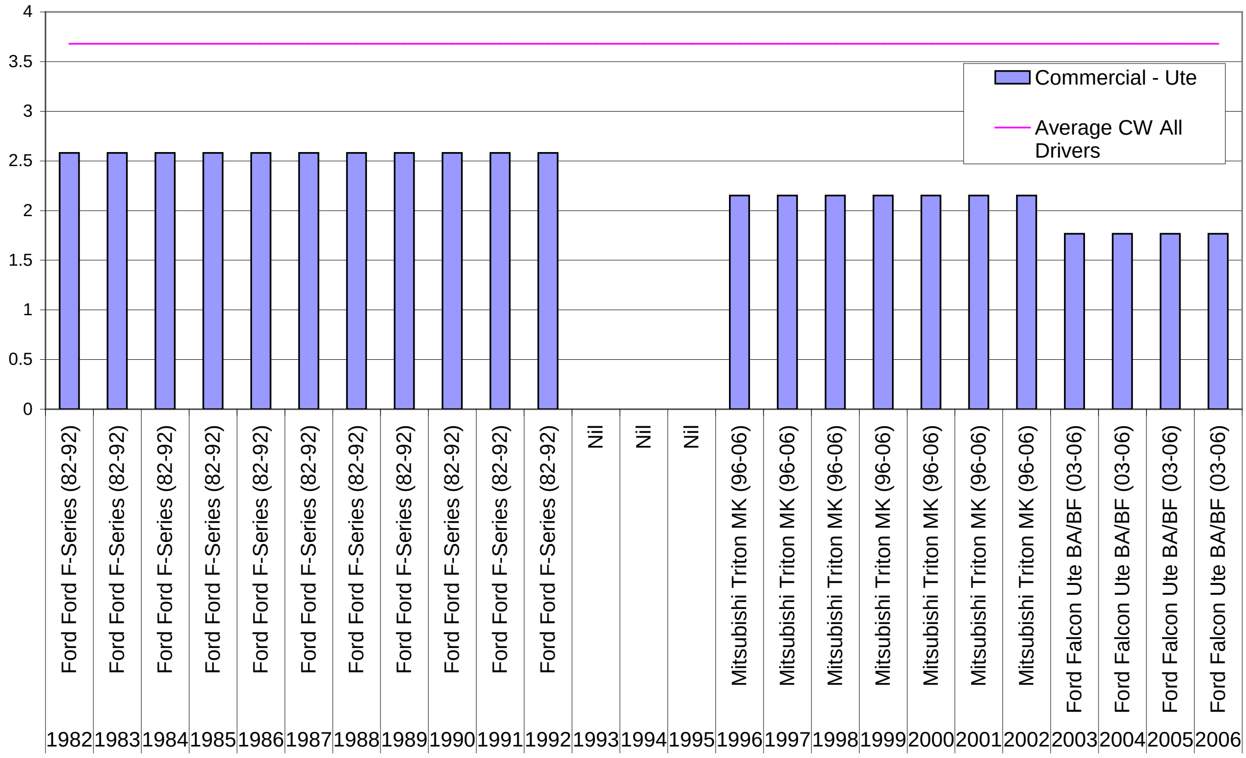

Figure 15 Most-crashworthy Commercial Ute by year of manufacture

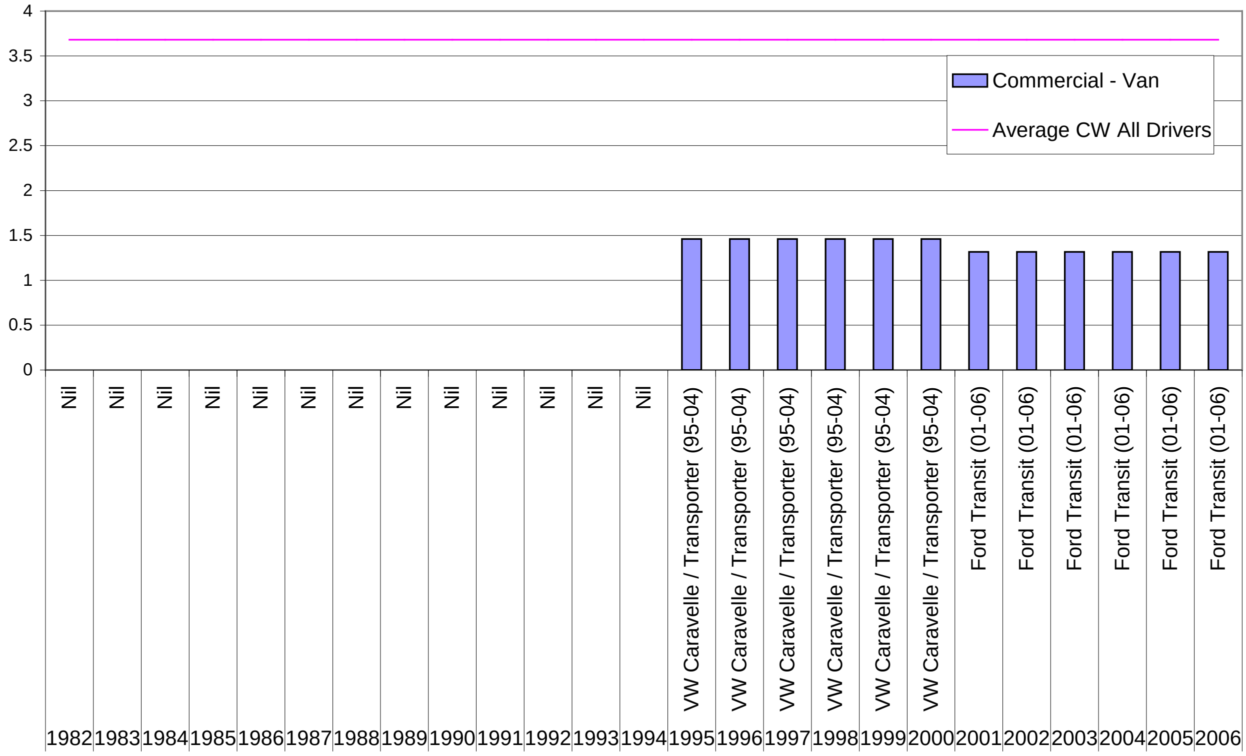

Figure 16 Most-crashworthy Commercial Van by year of manufacture

Commercial Vans scoring below the average crashworthiness rating (3.68%) were not manufactured until 1995 (Figure 16). It was only from 1995 that the Volkswagen Caravelle was manufactured with a crashworthiness rating that was significantly less than the crashworthiness of the vehicle fleet. From 2001 the Ford Transit became the commercial van with the best crashworthiness ratings (1.32%).

In 1982 and 1983 there were no large vehicles manufactured that had crashworthiness ratings that were lower than the average crashworthiness. Between 1984 and 1998 the most-crashworthy large cars were all imported from Europe. Previous phases of this study have indicated that large vehicles are a common choice for young drivers, especially male drivers. However, the types of large cars that would be popular choices among young male drivers would be unlikely to overlap with the vehicle models listed in Figure 17. The results here are interesting in that the most-crashworthy vehicle in one year is not necessarily more crashworthy than the most-crashworthy vehicle in the previous year. For example the Holden Statesman/Caprice was the most-crashworthy large car manufactured in 2002 but was less crashworthy than the BMW 7 series E38, which was the most-crashworthy car manufactured in the year immediately preceding (1999/2000). This interesting trend is most-pronounced in the large car market group, but can be observed in other market groups too (e.g. large 4WDs and medium cars).

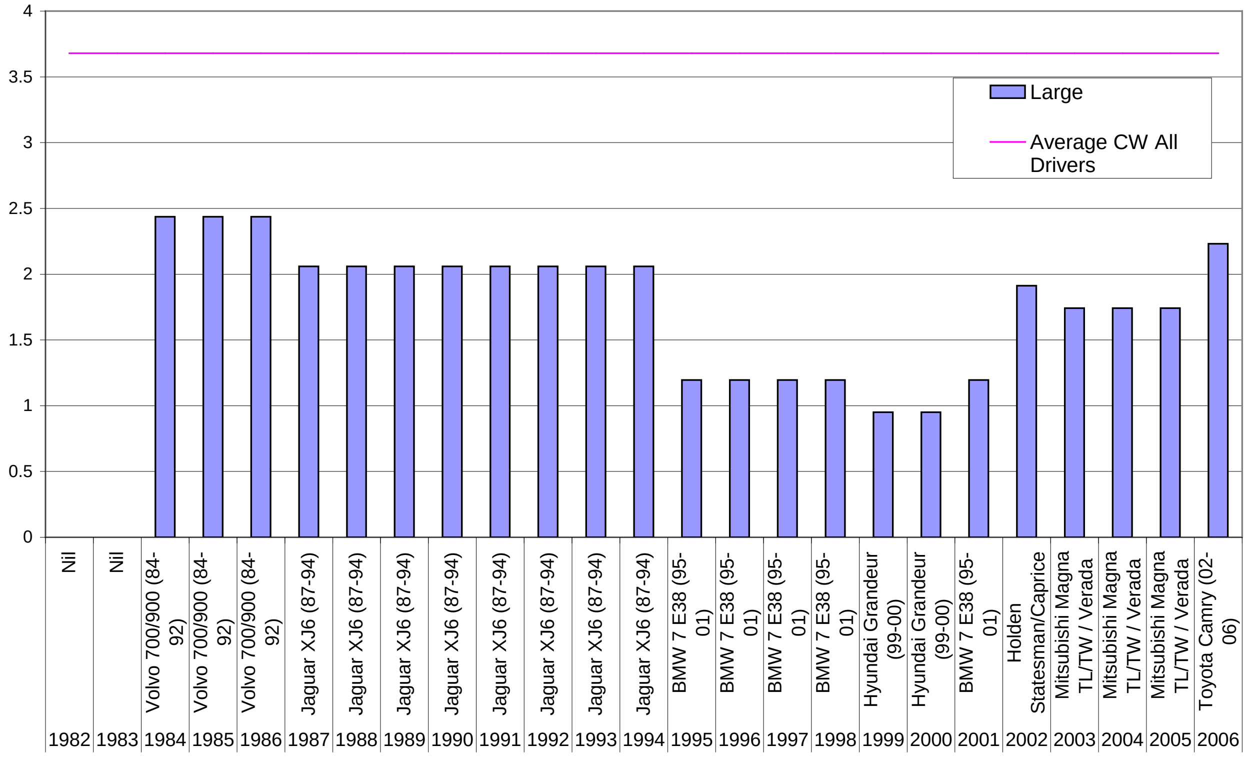

Figure 17 Most-crashworthy Large Car by year of manufacture

For luxury cars, five different models were identified as being the most-crashworthy luxury cars manufactured in a particular year (see Figure 18). The crashworthiness rating for these five models ranged from 1.21% to 2.50%.

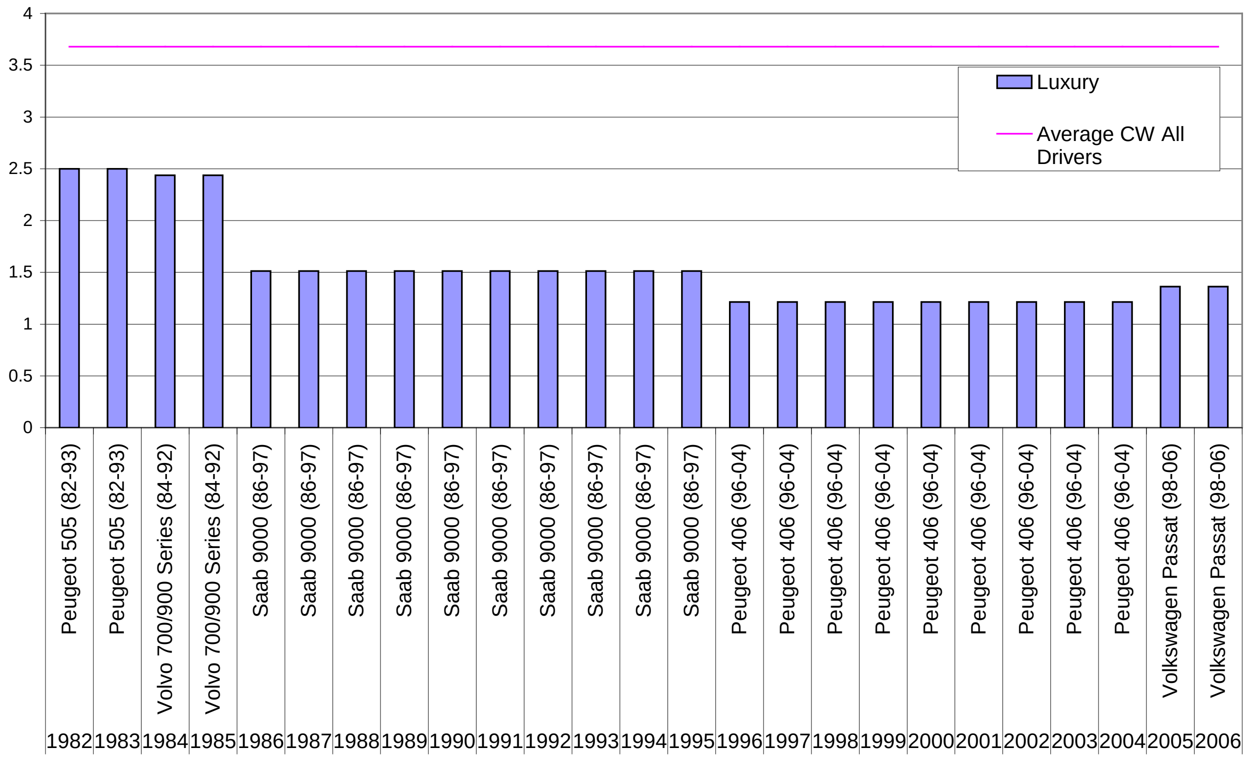

Figure 18 Most-crashworthy Luxury Car by year of manufacture

For medium cars (Figure 19), there were four distinct models that were identified as being the most-crashworthy medium cars manufactured in a particular year. The crashworthiness ratings of these four vehicles ranged from 1.21% to 2.50%.

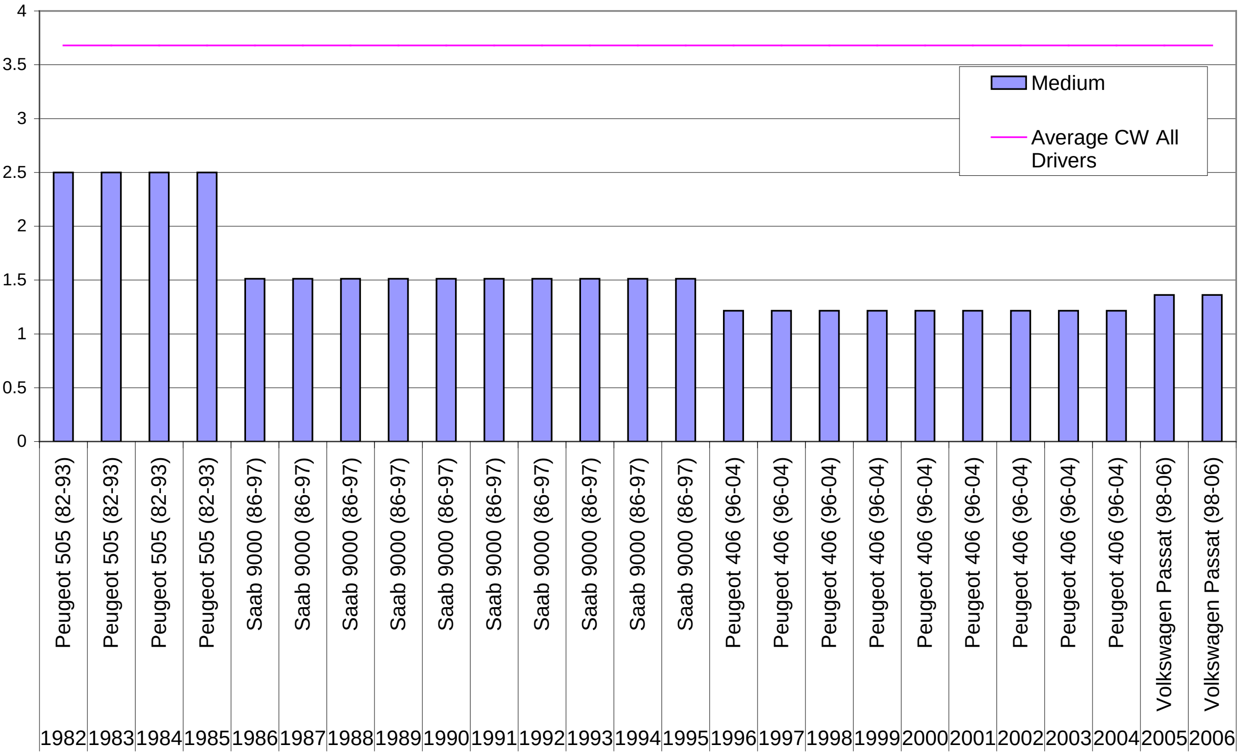

Figure 19 Most-crashworthy Medium Car by year of manufacture

As shown in Figure 20, no People mover vehicles manufactured prior to 1991 could be identified as being significantly ($p<0.1$) more crashworthy than the average vehicle. Between 1991 and 2006 four distinct models were identified as the most-crashworthy people mover manufactured for the year. The range of crashworthiness ratings for these vehicles was from 0.93% to 2.88%.

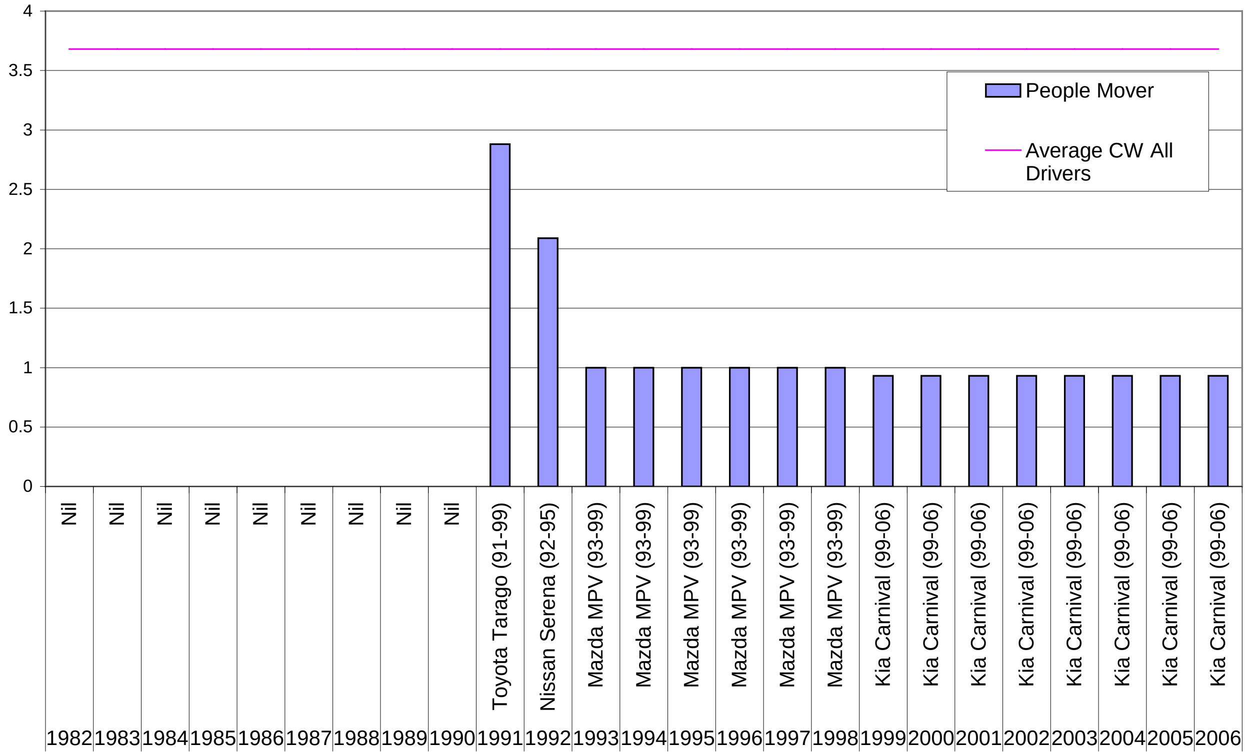

Figure 20 Most-crashworthy People Mover by year of manufacture

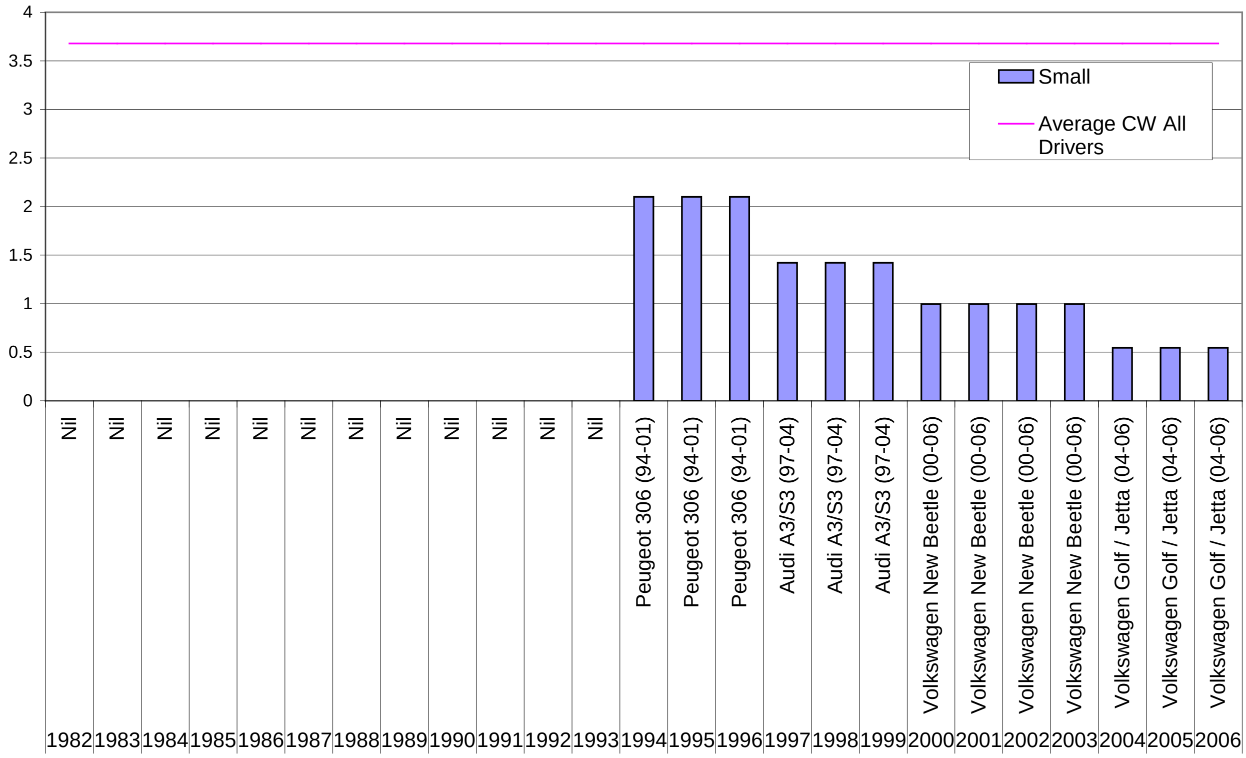

Figure 21 Most-crashworthy Small by year of manufacture

Interestingly, a safe option for small cars was not manufactured until 1994 (Figure 21). Between 1994 and 2006 there were four vehicle models that were deemed the most-crashworthy in their year. The range of crashworthiness ratings for these four models was from 0.55% to 2.10%.

No sports cars manufactured between 1982 and 2006 could be found that were significantly ($p<0.1$) more-crashworthy than the average vehicle in the data analysed (the all model average crashworthiness rating was 3.68%). The same was true of light cars. Therefore, it is not possible to make a vehicle recommendation for young drivers to drive a safer vehicle within these market categories. If a young driver drove either a sports car or a light car in the baseline scenario, it was assumed that they drove the same vehicle under Scenario 2b.

Figure 22 and Figure 23 provide a comparison between Scenarios 2a and 2b for Australia and New Zealand in terms of the number of serious injuries and fatalities prevented. Scenario 2b is more restrictive in terms of what vehicles can be selected (matching is restricted to vehicles of the same year and market group as opposed to just the same year). The stricter restrictions on what vehicles will be chosen by young drivers under Scenario 2b has meant that this scenario is less effective in reducing serious injury crashes than Scenario 2a.

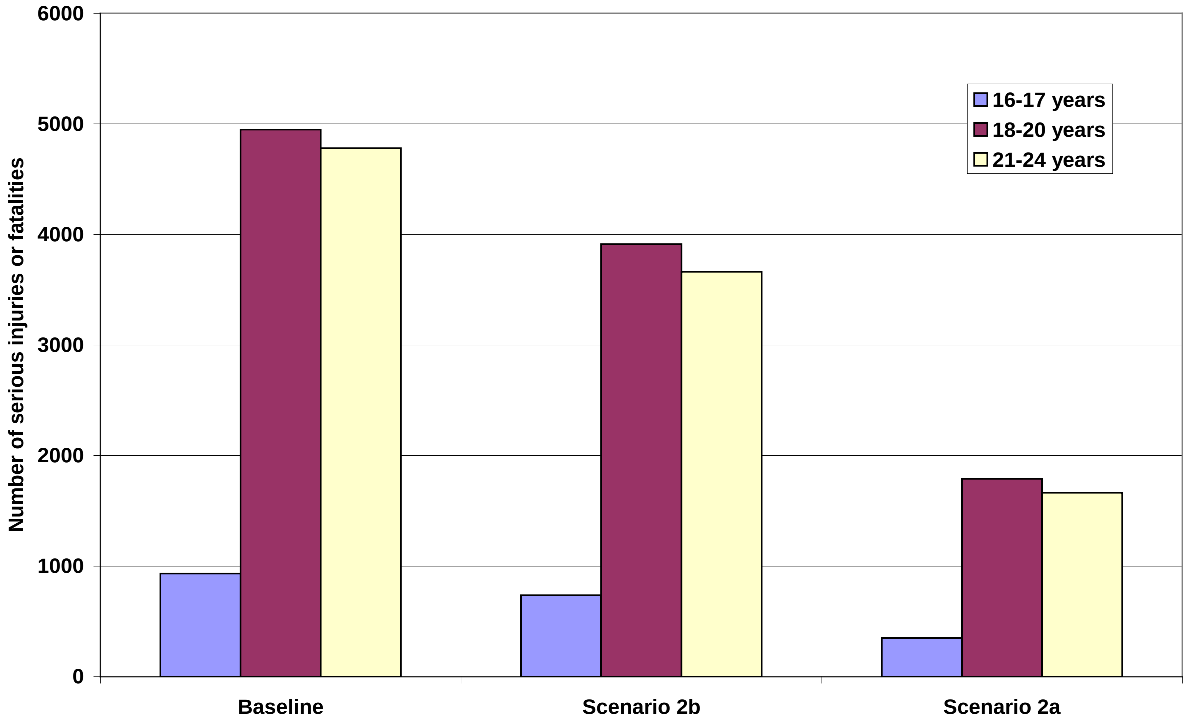

Figure 22 Comparison of reductions in serious injury and fatal crashes from baseline following treatments Scenario 2b and 2a (Australia).

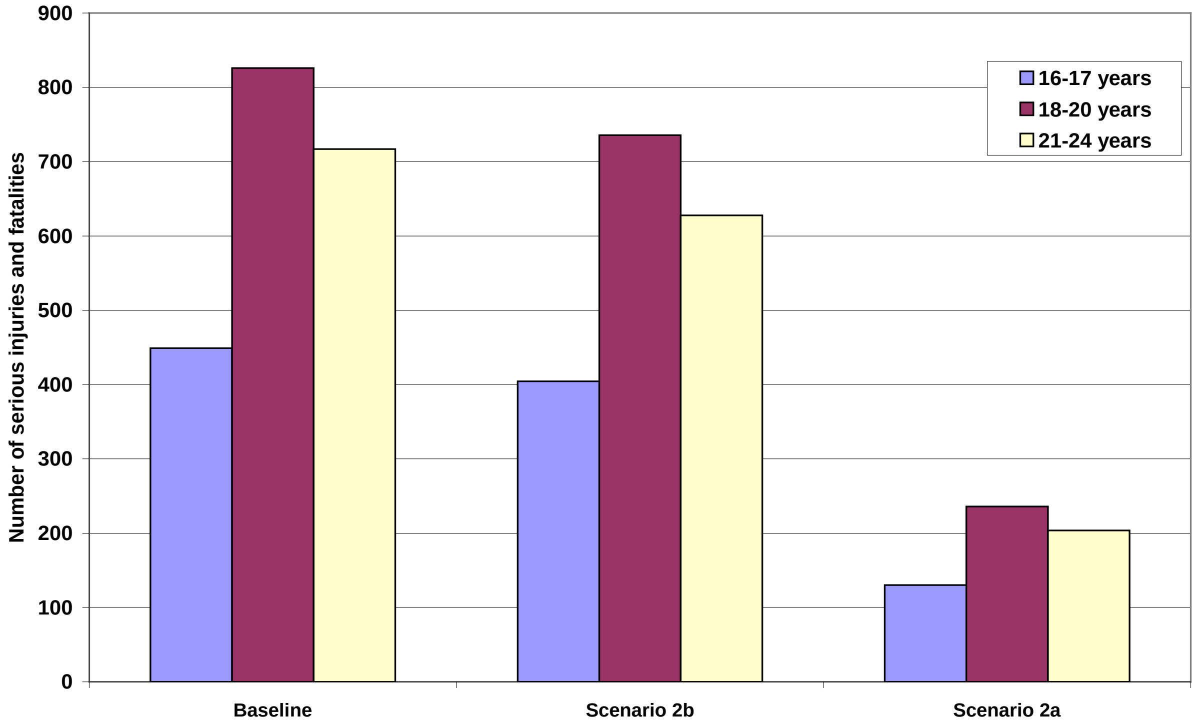

Figure 23 Comparison of reductions in serious injury and fatal crashes from baseline following treatments Scenario 2b and 2a (New Zealand).

6.4.3 Scenario 3

Section 6.3.2 explained how it was estimated that requiring that all young drivers drove cars fitted with Electronic Stability Control (ESC) would reduce the risk of young drivers being involved in a crash that resulted in them being seriously injured or killed.

Referring to Table 25, it was estimated that under Scenario 3, the risk of a 16-17 year old Australian driver being seriously injured or killed would reduce by 20.2%, while a 16.7% reduction in risk was estimated for 18-20 year old Australian drivers and a 15.9% reduction in risk was estimated for 21-24 year Australian drivers. From Table 26, the estimated reduction in risk for young New Zealand drivers under Scenario 3 was 17.5% for 16-17 year olds, 24.3% for 18-20 year olds and 17.5% for 21-24 year olds. Applying these estimates of risk reduction to the number of drivers observed to be seriously injured or killed in the period 2001-2005 enabled estimation of the number of young drivers who would be seriously injured or killed under Scenario 3 compared with the baseline scenario. Figure 24 shows the estimated number of young Australian drivers seriously injured or killed under Scenario 3 compared to the actual number seriously injured or killed in the period 2001-2005, while Figure 25 shows the analogous estimates for New Zealand young drivers.

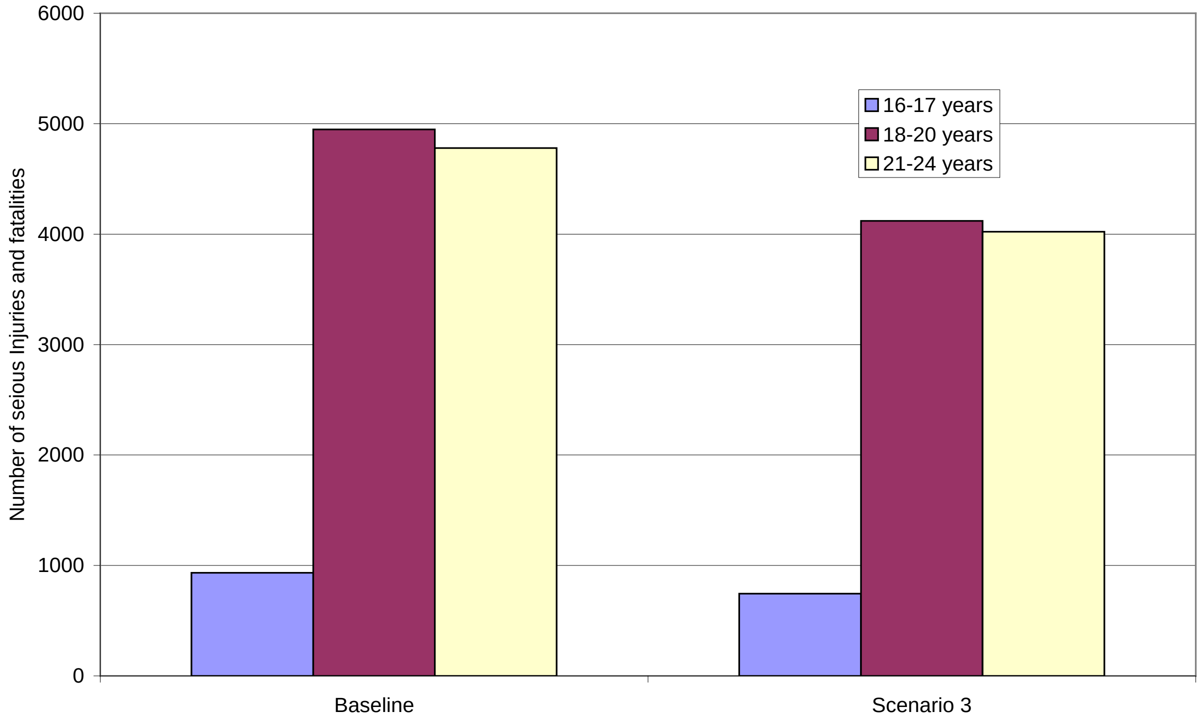

Figure 24 Comparison of reductions in serious injury and fatal crashes from baseline following treatments Scenario 3 (Australia)

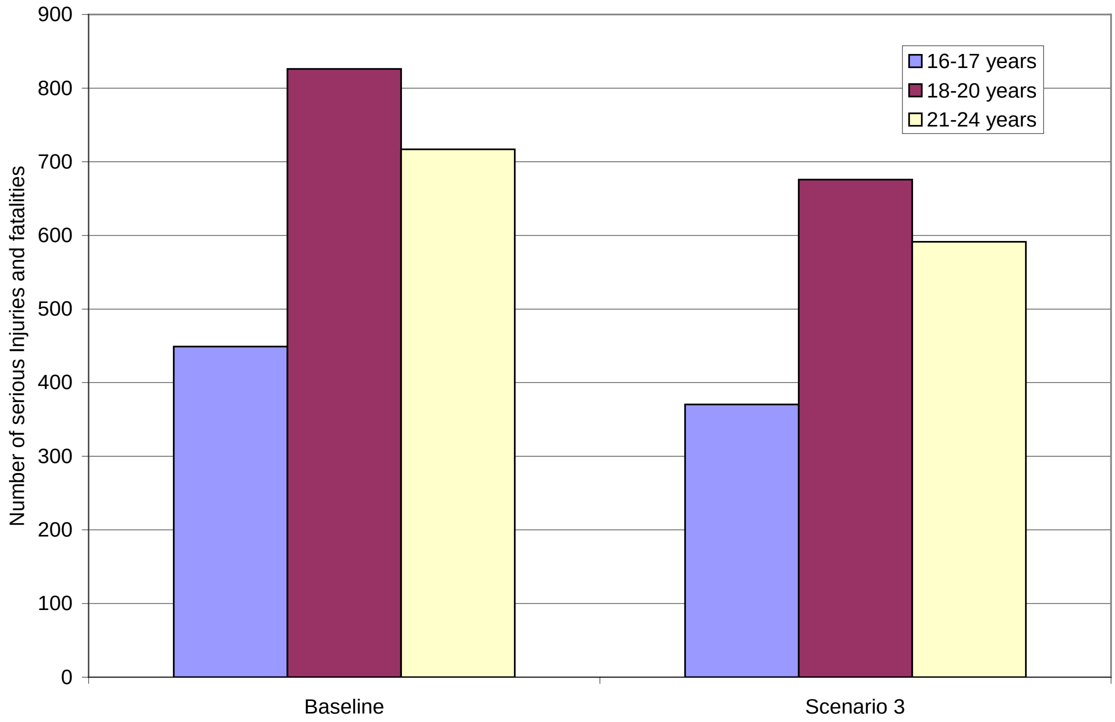

Figure 25 Comparison of reductions in serious injury and fatal crashes from baseline following treatments Scenario 3 (New Zealand)

Under Scenario 3, if all young drivers drove vehicles fitted with ESC, most of the vehicles driven by young drivers would have, in addition to the ESC technology, better secondary safety than the vehicles currently driven by young drivers. The analyses depicted in Figure 24 and Figure 25 only account for the effect of the ESC technology, not the additional secondary safety benefits found in vehicles equipped with ESC. Therefore the estimates of serious injuries and fatalities prevented under Scenario 3 should be considered conservative estimates of effectiveness.

7.0 Discussion

7.1 Summary of the findings of Stages 1 and 2

Stages 1 and 2 of this study have demonstrated two key findings regarding young drivers that were consistent across New Zealand and Australia. Firstly, it was found that young drivers tend to drive vehicles that have poor crashworthiness. Secondly, the types of crashes that young drivers are involved in are different to drivers aged 25 years or above, and these crashes are also likely to be more serious than when drivers aged 25 years or older are involved in similar types of crashes. The third and final phase of this study examined three scenarios in which the vehicle choices of young drivers are altered in order to optimise their safety. The findings of Stages 1 and 2, which focussed on the vehicle profile and crash risk of young drivers, were a factor in determining which alternative vehicle choice scenarios would have the greatest effect on young driver safety. A series of reports on the effect of safe vehicle purchases for fleet managers was also used to identify appropriate alternative vehicle choice scenarios (Scully & Newstead, 2007a; 2007b).

7.2 Ranking of the alternative vehicle choice scenarios

Table 28 shows a summary of the expected number of serious injury crashes involving young drivers that would be prevented if the vehicle choice practices of young drivers matched each of the alternative vehicle choice scenarios described in the results section. Scenarios are ranked in terms of the percentage of serious injuries and fatalities observed for young drivers over the period 2001-2005 that would have been prevented if young drivers were driving vehicles recommended under each of the alternative scenarios. It can be seen that for both Australia and New Zealand, Scenario 1a was the most successful in terms of preventing serious injury and fatal crashes. For both Australia and New Zealand, the next most-effective scenarios were Scenarios 1b, and 2a. However the least effective scenario for Australia was Scenario 3, which involved young drivers only driving vehicles fitted with ESC, while Scenario 2b was the least effective scenario for New Zealand which involved young drivers choosing the most-crashworthy vehicle that belonged to the same market group and year of manufacture as the vehicle they were actually driving when involved in a crash.

Table 28: Estimated number of serious injury crashes prevented (proportion of total serious injury crashes) by Vehicle Optimisation Scenario and driver age group

Scenario	Rank	16-17 years	18-20 years	21-24 years
Australia				
Scenario 1a	**1**	802 (85.9%)	4242 (85.7%)	4076 (85.3%)
Scenario 1b	**2**	685 (73.5%)	3617 (73.1%)	3452 (72.2%)
Scenario 2a	**3**	584 (62.6%)	3158 (63.8%)	3116 (65.2%)
Scenario 2b	**4**	196 (21.1%)	1035 (20.9%)	1118 (23.4%)
Scenario 3	**5**	188 (20.2%)	828 (16.7%)	759 (15.9%)
New Zealand				
Scenario 1a	**1**	403 (89.8%)	738 (89.4%)	638 (89.0%)
Scenario 1b	**2**	362 (80.7%)	661 (80.0%)	569 (79.3%)
Scenario 2a	**3**	319 (71.0%)	590 (71.4%)	513 (71.6%)
Scenario 2b	**5**	45 (9.9%)	90 (11.0%)	89 (12.5%)
Scenario 3	**4**	79 (17.5%)	150 (18.2%)	126 (17.5%)

Table 28 also enables the effectiveness of each alternative vehicle choice scenario to be compared across the three different young age groups. It is interesting that the effect of each alternative scenario was consistent across the different age groups. For example Scenario 1 was the most effective for 16-17 year olds, 18-20 year olds and 21-24 year olds in comparison to the effectiveness of other scenarios while Scenario 1b was the next most effective across each age group and so on.

The following sections discuss reasons why some alternative vehicle choice scenarios were more effective than others. Each section also addresses the extent to which the vehicle purchasing practices represented by each scenario could be adopted by young drivers. The first alternative vehicle purchasing scenario to be discussed is the scenario that was estimated to be the most effective in reducing the number of serious injuries and fatalities among young driver, i.e. Scenario 1.

7.3 Overview of findings for the three vehicle choice scenarios

The main result from this stage of the study was that Scenario 1a was the most effective vehicle choice scenario for reducing serious injures and fatalities among young drivers. Under this scenario young drivers' reduction in serious injury and fatal crashes was estimated if they were driving the most-crashworthy vehicle available. In their latest release of the Used Car Safety Ratings, Newstead, Watson & Cameron (2008) rated the Volkswagen Golf manufactured from 2004 to 2006 as the most-crashworthy vehicle available. The estimated crashworthiness for this vehicle was 0.54% risk of a driver being seriously injured or killed in a crash for each police-reported crash. For the purposes of comparison, the current vehicle choice practices of young drivers indicates that the average crashworthiness of vehicles driven by young Australian drivers seriously injured or killed was estimated to be 3.88% for 16-17 year olds, 3.83% for 18-20 year olds and 3.70% for 21-24 year olds. The average crashworthiness of vehicles driven by New Zealand young drivers when they were seriously injured or killed was poorer than that of their Australian counterparts: 5.33% for 16-17 year olds, 5.14% for 18-20 year olds and 4.97% of 21-24 year olds. Under Scenario 1a the estimated reduction in serious injuries and fatalities was approximately 86% for Australian young drivers and approximately 89% for New Zealand young drivers. In total this equates to almost 11,000 serious injuries and fatalities that would be prevented across Australia and New Zealand if young drivers drove the most-crashworthy vehicle. These results indicate that this is a highly effective strategy, and would clearly benefit the National Road Safety Strategy 2001-2010 target of less than 5.6 deaths per 100,000 population. The feasibility of implementation is not a primary goal of this report however it is an important consideration. Potentially Scenario 1a and 1b are the most restrictive and hence have more difficulties associated with implementation.

The least effective scenario was not the same for Australia and New Zealand. For Australia, Scenario 3 was the least effective. In this scenario all young drivers were driving a vehicle equipped with ESC. For New Zealand, Scenario 2b was the least effective. In this scenario the year of manufacture and vehicle market group of the young driver's crashed vehicle was matched with the most-crashworthy vehicle within the same year of manufacturer and vehicle market group. Overall, both Scenario 3 and Scenario 2b were much less effective than Scenario 1a, 1b, and 2a.

7.4 Real-world applications of vehicle choice research and feasibility of implementing vehicle choice scenarios

The cost and feasibility of implementing these scenarios will now be considered more closely. When examining the types of vehicles driven by young drivers it is clear that a broad range of models are driven by the young driver population in both Australia and New Zealand. However what most of these models of vehicles have in common is that they can be purchased for an affordable price as used cars. Table 29 presents the price range of the most-popular vehicles driven by young drivers who were seriously injured in crashes in Australia in the year 2004. Only models of vehicles for which there were more than twenty cases of a young driver being seriously injured in 2004 have been included. The most-popular models are listed at the top of the table. The prices for which these vehicles were available were determined using the Redbook Lookup program

(Redbook, 2009). Therefore these prices represent the price for which these vehicles are available in June 2009, not when they were most-likely purchased by the young driver. If the young driver was the owner of the vehicle that they crashed, it is likely that they would have been purchased at a more-expensive price than the price listed in Table 29. However despite this, it can be seen that among these most-popular models of vehicles, there were only two models where the upper price range for the model in June 2009 was in excess of $5,000 (i.e. the VT/VX Commodore and the Mitsubishi Lancer/Mirage).

Newstead, et al (2007) deemed most of the models listed in Table 29 as being poor in terms of crashworthiness when compared to the average crashworthiness of the Australian fleet. Specifically, Newstead, et al (2007) estimated that the average crashworthiness of the sample of crashed vehicles they used to derive their used car safety ratings was a 3.68% risk of a driver being seriously injured or killed when involved in a police-reported crash. The only models listed in Table 29 with a better crashworthiness rating than the average rating for the sample were the VR/VS Commodore, the EF/EL Falcon and the VT/VX Commodore (the point estimate for the EA/EB Falcon was not significantly less than the average crashworthiness estimate). The crashworthiness of the Toyota Camry manufactured from 1988 to 1992 (which is also marketed as a Holden Apollo) was also found not to be significantly different from the average crashworthiness estimate. However, Newstead, et al. (2007) estimated that the crashworthiness of each of the remaining eleven vehicles listed in Table 29 was significantly worse than the average crashworthiness of vehicles in the Australian fleet.

Table 29: Cost of the most popular vehicles driven by young drivers in Australia

Make	Model	Year of Manufacture	CWR	Price Range: Early model or Ave. Condition	Price Range: Good Condition or most-recent model
Holden	VN/VP Commodore	1988-1993	3.95%	$1,000	$3,100
Holden	VR/VS Commodore	1993-1997	3.10%	$1,400	$3,900
Holden	VB/VL Commodore	1982-1988	4.51%	$500	$2,100
Ford	EF/EL Falcon	1992-1998	3.03%	$900	$3,700
Toyota	Corolla	1982-1988	4.76%	$800	$2,300
Ford	EA/EB Falcon	1988-1992	3.59%	$800	$2,900
Holden	VT/VX Commodore	1997-2002	2.88%	$1,700	$8,200
Ford/Mazda	Laser/323	1982-1989	5.35%	$700	$2,000
Toyota	Corolla	1989-1994	4.26%	$1,100	$3,700
Ford	Festiva	1994-2000	5.64%	$1,100	$3,600
Ford	Laser	1991-1998	4.35%	$1,000	$4,800
Hyundai	Excel	1988-2000	4.71%	$700	$4,000
Mitsubishi	Lancer/Mirage	1997-2003	4.18%	$3,300	$8,850
Nissan	Pulsar/Vector	1983-1991	4.70%	$500	$2,400
Suzuki/Holden	Swift/Barina	1989-1997	5.39%	$1,000	$2,700
Toyota/Holden	Camry/Apollo	1988-1992	3.73%	$800	$3,500

Under Scenario 1a, each young driver would be recommended to drive a Volkswagen Golf/Jetta manufactured between 2004 to 2006. According to Redbook (Redbook, 2009), the minimum price for which this vehicle could be purchased for as a new vehicle was $25,990. Redbook also lists the average retail price of 2004 model Volkswagen Golf in June 2009 as between $13,000 and $16,000. Therefore, comparing the 2009 price of a 2004 Volkswagen Golf with the 2009 prices of the most-popular cars driven by seriously injured young drivers, it is clear that a used 2004 Volkswagen Golf cannot be purchased for the same price as the vehicles that are most-popular with young drivers.

Scenario 1b represents a more-flexible alternative purchasing scenario for young drivers compared with Scenario 1a. Instead of only purchasing the Volkswagen Golf, under Scenario 1b, young drivers can purchase a vehicle with a crashworthiness rating equal to the average rating for the ten most-crashworthy vehicles available. Table 30 shows the ten most-crashworthy vehicles along with the price for which these vehicles can be purchased as used vehicles in June 2009 according to Redbook (Redbook, 2009). It can be seen that of the ten vehicles, four are not available for less than $10,000. However the remaining six can be purchased for less than $10,000. In fact, for four of the models, older vehicles and vehicles of "average" condition can be purchased for less than $5,000. Specifically, according to Redbook, a 1999 model Kia Carnival can be purchased for $3,300 while a 1999 Hyundai Grandeur can be purchased for $3,700. Another relatively inexpensive choice of vehicle which offers good occupant protection is a 1993 model Mazda MPV which can be purchased for $4,100, while a 1996 model Peugeot 406 can be purchased for as little as $2,600. However while these vehicles are less expensive than the preferred vehicle under Scenario 1a, they are still more expensive than most of the vehicles popular with young drivers, which were presented in Table 29.

Table 30: Cost of vehicles purchased under Scenario 1b

			Price Range	
Make	Model	Year of Manufacture	Early model or Ave. Condition	Good Condition or most-recent model
Volkswagen	Golf / Jetta	2004-2006	$13,850	$15,750
Kia	Carnival	1999-2006	$3,300	$14,100
Hyundai	Grandeur	1999-2000	$3,700	$6,600
Volkswagen	New Beetle	2000-2006	$11,550	$17,150
Mazda	MPV	1993-1999	$4,100	$9,500
Ford	Explorer	2001-2005	$8,300	$28,050
Mercedes Benz	M-Class W163	1998-2005	$10,100	$20,550
BMW	7 Series E38	1995-2001	$9,500	$24,200
Peugeot	406	1996-2004	$2,600	$17,350
Lexus	IS200 / IS300	1999-2004	$10,900	$23,850

Under Scenario 2a young drivers who were driving a vehicle of a particular year of manufacture under the baseline scenario were instead assumed to be driving the most-crashworthy vehicle manufactured in that year. Table 31 shows the cost of the preferred model for each year of manufacture. The two right-most columns show the cost which these vehicles can be purchased for in June 2009. It can be seen that in general, more recently manufactured vehicles cost more than older vehicles.

For older vehicles, there is often only a small difference in price between the most-crashworthy vehicle manufactured in a particular year and the prices of models manufactured in the same year that are popular choices for young drivers (see Table 29). For example, one of the vehicles popular among young drivers is the Holden VB/VL Commodore which was manufactured from 1982 to 1988. These vehicles are estimated to provide worse than average protection to occupants with the point estimate of its crashworthiness rating being 4.51%, ranging from 4.34% to 4.69% with 90% certainty. According to Table 29, in June 2009, a 1988 model Commodore can be purchased for $2,100. However Table 7 demonstrates that a base model Saab 9000 that was manufactured in 1988 and which is in good condition can be purchased for $2,700, only $600 more than the Commodore. Furthermore, the Redbook estimate for a Saab 9000 in "average" condition is actually less than the cost of the Commodore in good condition. Newstead, Watson et al (2007) estimated that the Saab 9000 was significantly safer than the VB/VL Commodore, with the Saab's crashworthiness estimate being 1.51%, significantly better than the estimate for the Commodore (4.51%). Hence, Table 31 demonstrates that there are instances where young drivers can spend about the same amount that they currently spend on their vehicle purchases and still purchase a vehicle that is significantly safer than vehicles purchased using their current purchasing strategies. The missing link in the chain is being able to direct this market group of buyers (which includes parents) to the safest vehicles in their price range.

Table 31: Cost of vehicles purchased under scenario 2a

Year of Manufacture	Make	Model	Price Range Ave. Condition	Price Range Good Condition
1982	Peugeot	505	$700	$1,700
1983	Peugeot	505	$800	$1,700
1984	Volvo	700/900 Series	$1,000	$2,200
1985	Volvo	700/900 Series	$1,000	$2,300
1986	Saab	9000	$1,100	$2,400
1987	Saab	9000	$1,100	$2,400
1988	Saab	9000	$1,200	$2,700
1989	Saab	9000	$1,400	$3,100
1990	Saab	9000	$1,500	$3,300
1991	Saab	9000	$1,600	$3,600
1992	Saab	9000	$1,700	$3,800
1993	Mazda	MPV	$4,100	$6,000
1994	Mazda	MPV	$4,700	$6,500
1995	Mazda	MPV	$5,200	$7,200
1996	Mazda	MPV	$5,600	$7,500
1997	Mazda	MPV	$6,900	$8,800
1998	Mazda	MPV	$7,100	$9,000
1999	Kia	Carnival	$3,300	$4,700
2000	Kia	Carnival	$4,750	$6,200
2001	Kia	Carnival	$5,450	$6,850
2002	Kia	Carnival	$7,000	$8,550
2003	Kia	Carnival	$7,900	$9,400
2004	Volkswagen	Golf / Jetta	$13,850	$15,750
2005	Volkswagen	Golf / Jetta	$16,450	$18,500
2006	Volkswagen	Golf / Jetta	$17,300	$19,400

From these results it seems that the development of a tool that allows young drivers and their parents to search for vehicles by safety rating and price range would be quite beneficial. It has been demonstrated that the young driver group has the most crashes and most severe injury crash outcomes of any other age group. Furthermore, the vehicles that young drivers crash have the poorest average crashworthiness compared to vehicles driven by other age groups. Market research indicates that purchase price is a highly influential factor for consumers purchasing a vehicle. It is likely that purchase price, servicing and running costs all contribute to the purchaser's view of the overall cost of the vehicle. Furthermore the role of safety is generally low on the priority list of those in the market for a vehicle. Therefore, if vehicle purchase price and a vehicle safety score could be combined so that young drivers are able to search for makes and models of vehicles and compare them on safety this could potentially heavily influence their vehicle choice. The tool could be an online database or a brochure similar to the Used Car Safety Ratings Buyer's Guide.

There is a range of ways the tool could be used. For example, a young driver might have set a budget of $3000 and aims to buy a particular vehicle for around this price range. However, after using this initiative they discovered that by spending an extra $800 they could have a vehicle with a significantly higher safety rating and subsequently decide to buy the safer vehicle. Indeed a case in point is the popular vehicle choice of the 1988 Commodore in Table 29 ($2,100, crashworthy rating of 4.51%) in comparison to the 1988 Saab 9000 ($2,700, crashworthy rating of 1.5%). Another scenario is that by using the tool the young driver discovers that a vehicle in a different market group to the one they were searching is available for $2000 but has a higher safety rating than the vehicle they initially desired at $3000.

Another group of users of this vehicle choice tool is parents who would like to purchase a vehicle for their newly licensed son or daughter. For example, parents may have decided from the outset that they would like the vehicle to have an ANCAP rating of at least 4 stars, out of a total of 5. They can use the tool to search for the lowest priced vehicle with a rating of at least 4.

Scenario 2b was more restrictive than Scenario 2a in that the most-crashworthy vehicles were matched with the same year of manufacture and market group. Appendix D contains a list of the preferred models for young drivers to purchase under the constraints of Scenario 2b along with the prices (as of June 2009) for which these vehicles can be purchased (Redbook, 2009). It can be seen that restricting alternative vehicle choices by market group as well as year of manufacture meant that the most-crashworthy vehicles available in each market group and year of manufacture category were often substantially more expensive than the cost of vehicles that were popular choices among young drivers (see Table 29). This highlights that in order to keep the cost of purchasing a safe car to reasonable levels, young drivers should be encouraged to make safety their number one priority when buying a car. If the young driver restricts the vehicles they are considering buying to only a particular market group of a certain age, the additional cost of purchasing a safe vehicle will be prohibitive for many market groups. For example, if a young driver was intent on purchasing a compact 4WD that was manufactured from 1997 onwards the most-crashworthy vehicle of this type is a 1997 Honda CR-V which, according to Redbook, can be purchased for about $5,800. However if the young driver was encouraged to place no restrictions on market group, they could purchase a 1999 Hyundai Grandeur from about $3,700. Not only is the Hyundai cheaper than the Honda CR-V but it also has a better estimated crashworthiness rating (0.95% compared with 2.13%).

It is interesting to note that under Scenario 2b, for several market groups, vehicles that offered significantly better than average crashworthiness were not available until quite recently. For example, it can be seen from Figure 19 that prior to 1994 no small car offered significantly better crashworthiness than the average vehicle. In 1994 the Peugeot 306 was released, which Newstead, Watson et al (2008) rated as offering significantly better crashworthiness than the average vehicle. That is, it was estimated that the Peugeot 306 offered a 2.1% risk of serious injury per police reported crash. Then in 1996, Audi released its A3 small car which was rated as having even better crashworthiness than the Peugeot 306 (1.4%). Similarly, in 2000 the Volkswagen Beetle was released and this vehicle has since been estimated to have a superior crashworthiness rating to any small vehicle produced until then (1.0%). However in 2004 the Volkswagen Golf/Jetta assumed the mantle of the most-crashworthy small car with a rating of 0.54%.

Figure 17 outlined the most-crashworthy vehicles in the large car market group that were manufactured between 1982-2006. It can be seen that for large cars that the most-crashworthy vehicle in one year was not necessarily more crashworthy than the most-crashworthy vehicle in the previous year. This contradicts conventional wisdom. That is, if a manufacture produces a vehicle that represents a new benchmark in crashworthiness then it would be expected that other manufactures would aim to improve on this benchmark by producing a vehicle with a higher crashworthy rating, meaning that the most-crashworthy large vehicle in following years should be safer than the safest large vehicles of the past. The fact that the most-crashworthy large vehicles manufactured in the period 1995-2000 were actually more crashworthy than the most-crashworthy vehicles manufactured in later years suggests that the market for new large cars is not safety driven.

It is possible that consumers were choosing vehicles based on non-safety factors such as purchase price, servicing and running costs, performance or aesthetics, and that these returns were driving manufacturers to produce new cars with less of a focus on maintaining safety levels.

It was also discovered that the sports and light vehicle market groups did not have any vehicles that were significantly safer than average. It is important to actively encourage young drivers to avoid these vehicle market groups per se. In addition to these vehicle market groups, Keall, Newstead, & Watson (2006) have demonstrated that 4WDs are not suitable for young drivers to drive. They have recommended that young drivers drive cars rather than 4WDs, due to problems with vehicle rollover, i.e. 4WDs have very high rollover rates, particularly in the hands of young drivers, and generally have severe injury outcomes. Despite some 4WDs offering quite good secondary safety it is argued that young drivers avoid this market group, in addition to sports cars and light cars.

Scenario 3 indicated only moderate success in the prevention of serious injuries and crashes by having all vehicles driven by young drivers equipped with ESC. It should be kept in mind that when evaluating this scenario, the estimation of serious injuries and fatalities prevented was probably conservative. This is because the analyses only accounted for the ESC technology, not the additional secondary safety benefits found in vehicles equipped with ESC. The additional cost to manufacturers of ESC is minimal. Therefore this technology is commonly available on new vehicles. However, according to Scully & Newstead (2008) it will be some years before the technology filters down to the vehicles driven by young drivers as most of the vehicles fitted with ESC won't be in the purchase price range available to young drivers, as most ESC equipped vehicles are either recently manufactured (post-2006) or luxury models.

7.5 Issues pertaining to the closed used car fleet in Australia

An issue that should be noted is that in Australia vehicles exist in a closed fleet. That is, unlike in New Zealand, generally used vehicles are not imported. This means Australian young drivers' vehicle choice is limited to the types of new vehicles bought by Australian drivers 5-10 years ago. In New Zealand, used vehicle are imported and so there is a mechanism to immediately improve the quality of the used cars available to young buyers by importing safer used vehicles. This means that the chance of achieving any of the scenarios considered in this report in the short term in Australia is unlikely.

New Zealand is in a position to choose the best used cars from overseas; they are not necessarily limited to the poor purchasing choices of the new car buyers in the recent past. On the one hand this means there is a lot of used cars on the market so the New Zealand fleet is older, but it also means that New Zealand buyers can potentially purchase high quality used cars. The closed used fleet structure of the Australian vehicle market and the influence that purchase price plays in vehicle choice are among several issues that should be considered when developing strategies to optimise the vehicle choice of young drivers. The current study has indicated that gains can be made in the area of vehicle choice optimisation. The following section outlines recommendations and future research.

8.0 CONCLUSIONS AND RECOMMENDATIONS

This study has demonstrated that it is possible to reduce the number of serious injuries and fatalities if the vehicle choices of young drivers move towards vehicles with favourable crashworthiness ratings. Transfer of this research knowledge to the general public to ensure better vehicle choices for young drivers is critical. As discussed in Section 7.4, one approach to disseminating the results of the study to the public could be through the development of a web-based or booklet based tool that allows comparisons of price and vehicle safety score so that young drivers and their parents are able to make informed decisions about the purchase of a young driver's vehicle. Indeed this tool is consistent with the aims of the 2001-2010 National Road Safety Strategy which aims to develop a vehicle choice optimisation initiative targeting young drivers.

The study results have led to the following recommendations:

- The development of an initiative that aims to improve young driver vehicle choice. The initiative should be developed with the aim of allowing young drivers and their parents to make informed choices about upcoming vehicle purchases by comparing the purchase price of all vehicles with their relative vehicle safety scores;
- Discourage young drivers from driving unsafe market groups – 4WDs, light cars and sports cars;
- Encourage ESC and other vehicle technologies in vehicles driven by young drivers;
- Evaluate the effectiveness of the GDLS component that restricts high-powered vehicles;
- Undertake future research that aims to develop a vehicle safety restriction linked to the licensing system for all novice drivers. For example, restricting learner and intermediate drivers to vehicles above a particular crashworthiness or ANCAP rating;
- Conduct further research which aims to reduce the high rate of night-time crashes through vehicle choice optimisation;
- Investigate the advantages of a grey used car import program for Australia, to provide young drivers with a greater range of safe vehicles for purchase;
- Develop initiatives that provide financial incentives for young drivers to purchase safer vehicles, for example, through reduced registration or insurance premiums; and,
- Investigate the application of vehicle scrappage programs for Australia, for example, the U.S based "cash for clunkers" whereby drivers are provided with financial incentives to replace their old vehicle for a newer vehicle (Hahn, 1995). The two major benefits resulting from vehicle scrappage programs are that that the replacement vehicles are generally safer and also that they are more environmentally friendly than the driver's previous vehicle.

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APPENDIX A: VEHICLE PROFILE ANALYSIS OF VEHICLE MARKET GROUP

Table A1: Distribution of time of crash by vehicle market group and sex for all serious injury crashes for drivers aged 16-24 years in Australia

Sex	Vehicle Market Group	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
Male						
	Unknown	846 (58%)	578 (57.1%)	853 (59.1%)	1213 (55.7%)	3490 (57.3%)
	4WD - Compact	5 (0.3%)	4 (0.4%)	5 (0.3%)	9 (0.4%)	23 (0.4%)
	4WD - Large	18 (1.2%)	8 (0.8%)	14 (1%)	25 (1.1%)	65 (1.1%)
	4WD - Medium	3 (0.2%)	3 (0.3%)	3 (0.2%)	2 (0.1%)	11 (0.2%)
	Commercial – Ute	65 (4.5%)	61 (6%)	66 (4.6%)	127 (5.8%)	319 (5.2%)
	Commercial - Van	4 (0.3%)	3 (0.3%)	5 (0.3%)	10 (0.5%)	22 (0.4%)
	Large	293 (20.1%)	180 (17.8%)	289 (20%)	411 (18.9%)	1173 (19.3%)
	Luxury	9 (0.6%)	5 (0.5%)	9 (0.6%)	13 (0.6%)	36 (0.6%)
	Medium	41 (2.8%)	32 (3.2%)	38 (2.6%)	73 (3.4%)	184 (3%)
	People Mover	6 (0.4%)	2 (0.2%)	3 (0.2%)	13 (0.6%)	24 (0.4%)
	Small	98 (6.7%)	85 (8.4%)	107 (7.4%)	175 (8%)	465 (7.6%)
	Light	59 (4%)	46 (4.5%)	45 (3.1%)	92 (4.2%)	242 (4%)
	Sports	11 (0.8%)	6 (0.6%)	7 (0.5%)	15 (0.7%)	39 (0.6%)
	All Market Groups	1458 (100%)	1013 (100%)	1444 (100%)	2178 (100%)	6093 (100%)
Female						
	Unknown	302 (55.6%)	479 (53.9%)	340 (51.7%)	1266 (49.8%)	2387 (51.6%)
	4WD - Compact	4 (0.7%)	8 (0.9%)	2 (0.3%)	34 (1.3%)	48 (1%)
	4WD - Large	1 (0.2%)	3 (0.3%)	3 (0.5%)	17 (0.7%)	24 (0.5%)
	4WD - Medium	3 (0.6%)	3 (0.3%)	3 (0.5%)	5 (0.2%)	14 (0.3%)
	Commercial - Ute	9 (1.7%)	17 (1.9%)	10 (1.5%)	43 (1.7%)	79 (1.7%)
	Commercial - Van	0 (0%)	0 (0%)	1 (0.2%)	8 (0.3%)	9 (0.2%)
	Large	58 (10.7%)	114 (12.8%)	82 (12.5%)	267 (10.5%)	521 (11.3%)
	Luxury	4 (0.7%)	4 (0.4%)	3 (0.5%)	14 (0.6%)	25 (0.5%)
	Medium	20 (3.7%)	26 (2.9%)	21 (3.2%)	83 (3.3%)	150 (3.2%)
	People Mover	2 (0.4%)	2 (0.2%)	4 (0.6%)	5 (0.2%)	13 (0.3%)
	Small	74 (13.6%)	116 (13%)	107 (16.3%)	420 (16.5%)	717 (15.5%)
	Light	64 (11.8%)	114 (12.8%)	80 (12.2%)	365 (14.4%)	623 (13.5%)
	Sports	2 (0.4%)	3 (0.3%)	2 (0.3%)	13 (0.5%)	20 (0.4%)
	All Market Groups	543 (100%)	889 (100%)	658 (100%)	2540 (100%)	4630 (100%)
M, F or Unknown						
	Unknown	1149 (57.4%)	1057 (55.5%)	1193 (56.8%)	2479 (52.5%)	5878 (54.8%)
	4WD - Compact	9 (0.4%)	12 (0.6%)	7 (0.3%)	43 (0.9%)	71 (0.7%)
	4WD - Large	19 (0.9%)	11 (0.6%)	17 (0.8%)	42 (0.9%)	89 (0.8%)
	4WD - Medium	6 (0.3%)	6 (0.3%)	6 (0.3%)	7 (0.1%)	25 (0.2%)
	Commercial - Ute	74 (3.7%)	78 (4.1%)	76 (3.6%)	170 (3.6%)	398 (3.7%)
	Commercial - Van	4 (0.2%)	3 (0.2%)	6 (0.3%)	18 (0.4%)	31 (0.3%)
	Large	352 (17.6%)	294 (15.4%)	371 (17.6%)	678 (14.4%)	1695 (15.8%)
	Luxury	13 (0.6%)	9 (0.5%)	12 (0.6%)	27 (0.6%)	61 (0.6%)
	Medium	61 (3%)	58 (3%)	59 (2.8%)	156 (3.3%)	334 (3.1%)
	People Mover	8 (0.4%)	4 (0.2%)	7 (0.3%)	18 (0.4%)	37 (0.3%)

Sex	Vehicle Market Group	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
	Small	172 (8.6%)	202 (10.6%)	214 (10.2%)	596 (12.6%)	1184 (11%)
	Light	123 (6.1%)	160 (8.4%)	125 (5.9%)	458 (9.7%)	866 (8.1%)
	Sports	13 (0.6%)	9 (0.5%)	9 (0.4%)	28 (0.6%)	59 (0.5%)
	All Market Groups	2003 (100%)	1903 (100%)	2102 (100%)	4720 (100%)	10728 (100%)

Table A2: Distribution of crash type by vehicle market group and sex for all serious injury crashes for drivers aged 16-24 years, in Australia

Sex	Vehicle Market Group	Single-vehicle	Multiple Vehicle	Unprotected road user	Other	Total
Male						
	Unknown	2125 (57.3%)	1356 (57.2%)	3 (42.9%)	6 (40%)	3490 (57.2%)
	4WD - Compact	13 (0.4%)	11 (0.5%)	0 (0%)	0 (0%)	24 (0.4%)
	4WD - Large	57 (1.5%)	9 (0.4%)	0 (0%)	0 (0%)	66 (1.1%)
	4WD - Medium	8 (0.2%)	3 (0.1%)	0 (0%)	0 (0%)	11 (0.2%)
	Commercial - Ute	211 (5.7%)	106 (4.5%)	1 (14.3%)	3 (20%)	321 (5.3%)
	Commercial - Van	13 (0.4%)	10 (0.4%)	0 (0%)	0 (0%)	23 (0.4%)
	Large	765 (20.6%)	412 (17.4%)	2 (28.6%)	0 (0%)	1179 (19.3%)
	Luxury	22 (0.6%)	14 (0.6%)	0 (0%)	0 (0%)	36 (0.6%)
	Medium	113 (3%)	70 (3%)	0 (0%)	1 (6.7%)	184 (3%)
	People Mover	12 (0.3%)	12 (0.5%)	0 (0%)	0 (0%)	24 (0.4%)
	Small	224 (6%)	240 (10.1%)	1 (14.3%)	2 (13.3%)	467 (7.6%)
	Light	121 (3.3%)	117 (4.9%)	0 (0%)	3 (20%)	241 (3.9%)
	Sports	27 (0.7%)	12 (0.5%)	0 (0%)	0 (0%)	39 (0.6%)
	All Market Groups	3711 (100%)	2372 (100%)	7 (100%)	15 (100%)	6105 (100%)
Female						
	Unknown	975 (52.8%)	1409 (50.7%)	1 (20%)	8 (61.5%)	2393 (51.5%)
	4WD - Compact	25 (1.4%)	23 (0.8%)	0 (0%)	0 (0%)	48 (1%)
	4WD - Large	18 (1%)	6 (0.2%)	0 (0%)	0 (0%)	24 (0.5%)
	4WD - Medium	8 (0.4%)	6 (0.2%)	0 (0%)	0 (0%)	14 (0.3%)
	Commercial - Ute	55 (3%)	24 (0.9%)	0 (0%)	0 (0%)	79 (1.7%)
	Commercial - Van	4 (0.2%)	5 (0.2%)	0 (0%)	0 (0%)	9 (0.2%)
	Large	266 (14.4%)	256 (9.2%)	1 (20%)	1 (7.7%)	524 (11.3%)
	Luxury	10 (0.5%)	15 (0.5%)	0 (0%)	0 (0%)	25 (0.5%)
	Medium	54 (2.9%)	97 (3.5%)	0 (0%)	1 (7.7%)	152 (3.3%)
	People Mover	5 (0.3%)	8 (0.3%)	0 (0%)	0 (0%)	13 (0.3%)
	Small	212 (11.5%)	500 (18%)	2 (40%)	3 (23.1%)	717 (15.4%)
	Light	208 (11.3%)	417 (15%)	1 (20%)	0 (0%)	626 (13.5%)
	Sports	8 (0.4%)	12 (0.4%)	0 (0%)	0 (0%)	20 (0.4%)
	All Market Groups	1848 (100%)	2778 (100%)	5 (100%)	13 (100%)	4644 (100%)
M, F or Unknown						
	Unknown	3101 (55.7%)	2765 (53.7%)	4 (33.3%)	14 (50%)	5884 (54.7%)
	4WD - Compact	38 (0.7%)	34 (0.7%)	0 (0%)	0 (0%)	72 (0.7%)
	4WD - Large	75 (1.3%)	15 (0.3%)	0 (0%)	0 (0%)	90 (0.8%)
	4WD - Medium	16 (0.3%)	9 (0.2%)	0 (0%)	0 (0%)	25 (0.2%)
	Commercial - Ute	266 (4.8%)	130 (2.5%)	1 (8.3%)	3 (10.7%)	400 (3.7%)
	Commercial - Van	17 (0.3%)	15 (0.3%)	0 (0%)	0 (0%)	32 (0.3%)
	Large	1032 (18.6%)	668 (13%)	3 (25%)	1 (3.6%)	1704 (15.8%)
	Luxury	32 (0.6%)	29 (0.6%)	0 (0%)	0 (0%)	61 (0.6%)
	Medium	167 (3%)	167 (3.2%)	0 (0%)	2 (7.1%)	336 (3.1%)
	People Mover	17 (0.3%)	20 (0.4%)	0 (0%)	0 (0%)	37 (0.3%)

Sex	Vehicle Market Group	Single-vehicle	Multiple Vehicle	Unprotected road user	Other	Total
	Small	437 (7.9%)	741 (14.4%)	3 (25%)	5 (17.9%)	1186 (11%)
	Light	330 (5.9%)	534 (10.4%)	1 (8.3%)	3 (10.7%)	868 (8.1%)
	Sports	35 (0.6%)	24 (0.5%)	0 (0%)	0 (0%)	59 (0.5%)
	All Market Groups	5563 (100%)	5151 (100%)	12 (100%)	28 (100%)	10754 (100%)

Table A3: Distribution of road surface at crash site by vehicle market group and sex for all serious injury crashes for drivers aged 16-24 years, in Australia

Sex	Vehicle Market Group	Wet	Dry	Total
Male	Unknown	691 (59%)	2786 (56.7%)	3477 (57.2%)
	4WD - Compact	3 (0.3%)	21 (0.4%)	24 (0.4%)
	4WD - Large	4 (0.3%)	62 (1.3%)	66 (1.1%)
	4WD - Medium	3 (0.3%)	8 (0.2%)	11 (0.2%)
	Commercial - Ute	46 (3.9%)	275 (5.6%)	321 (5.3%)
	Commercial - Van	5 (0.4%)	18 (0.4%)	23 (0.4%)
	Large	237 (20.2%)	941 (19.2%)	1178 (19.4%)
	Luxury	4 (0.3%)	31 (0.6%)	35 (0.6%)
	Medium	31 (2.6%)	153 (3.1%)	184 (3%)
	People Mover	5 (0.4%)	19 (0.4%)	24 (0.4%)
	Small	85 (7.3%)	376 (7.7%)	461 (7.6%)
	Light	49 (4.2%)	190 (3.9%)	239 (3.9%)
	Sports	9 (0.8%)	30 (0.6%)	39 (0.6%)
	Total	1172 (100%)	4910 (100%)	6082 (100%)
Female	Unknown	495 (53.5%)	1889 (51.1%)	2384 (51.6%)
	4WD - Compact	7 (0.8%)	40 (1.1%)	47 (1%)
	4WD - Large	1 (0.1%)	23 (0.6%)	24 (0.5%)
	4WD - Medium	1 (0.1%)	13 (0.4%)	14 (0.3%)
	Commercial - Ute	21 (2.3%)	58 (1.6%)	79 (1.7%)
	Commercial - Van	2 (0.2%)	7 (0.2%)	9 (0.2%)
	Large	96 (10.4%)	423 (11.4%)	519 (11.2%)
	Luxury	7 (0.8%)	18 (0.5%)	25 (0.5%)
	Medium	32 (3.5%)	120 (3.2%)	152 (3.3%)
	People Mover	3 (0.3%)	10 (0.3%)	13 (0.3%)
	Small	134 (14.5%)	580 (15.7%)	714 (15.4%)
	Light	122 (13.2%)	502 (13.6%)	624 (13.5%)
	Sports	4 (0.4%)	16 (0.4%)	20 (0.4%)
	Total	925 (100%)	3699 (100%)	4624 (100%)
M, F or Unknown	Unknown	1186 (56.6%)	4676 (54.3%)	5862 (54.7%)
	4WD - Compact	10 (0.5%)	61 (0.7%)	71 (0.7%)
	4WD - Large	5 (0.2%)	85 (1%)	90 (0.8%)
	4WD - Medium	4 (0.2%)	21 (0.2%)	25 (0.2%)
	Commercial - Ute	67 (3.2%)	333 (3.9%)	400 (3.7%)
	Commercial - Van	7 (0.3%)	25 (0.3%)	32 (0.3%)
	Large	333 (15.9%)	1365 (15.8%)	1698 (15.9%)
	Luxury	11 (0.5%)	49 (0.6%)	60 (0.6%)
	Medium	63 (3%)	273 (3.2%)	336 (3.1%)
	People Mover	8 (0.4%)	29 (0.3%)	37 (0.3%)
	Small	219 (10.4%)	958 (11.1%)	1177 (11%)
	Light	171 (8.2%)	693 (8%)	864 (8.1%)
	Sports	13 (0.6%)	46 (0.5%)	59 (0.6%)
	Total	2097 (100%)	8614 (100%)	10711 (100%)

APPENDIX B: CRASH AND VEHICLE PROFILE ANALYSIS OF NEW ZEALAND CRASH DATA

Table B5: Distribution of time of crash by driver age and sex for New Zealand data, for all crash severities

Age/sex groups	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
Male					
16-17	537 (19.4%)	534 (19.3%)	395 (14.3%)	1297 (46.9%)	2763 (100%)
18-20	989 (19.2%)	976 (19%)	850 (16.5%)	2323 (45.2%)	5138 (100%)
21-24	755 (16.3%)	908 (19.7%)	685 (14.8%)	2270 (49.2%)	4618 (100%)
25+	2125 (7.8%)	5748 (21.2%)	2475 (9.1%)	16795 (61.9%)	27143 (100%)
Unknown	75 (18%)	84 (20.1%)	70 (16.8%)	188 (45.1%)	417 (100%)
All age	4481 (11.2%)	8250 (20.6%)	4475 (11.2%)	22873 (57.1%)	40079 (100%)
Female					
16-17	205 (14.4%)	261 (18.3%)	184 (12.9%)	778 (54.5%)	1428 (100%)
18-20	265 (10.2%)	552 (21.2%)	326 (12.5%)	1455 (56%)	2598 (100%)
21-24	215 (8%)	549 (20.4%)	262 (9.8%)	1661 (61.8%)	2687 (100%)
25+	803 (4.2%)	3597 (18.8%)	1136 (5.9%)	13571 (71%)	19107 (100%)
Unknown	34 (13.5%)	72 (28.7%)	29 (11.6%)	116 (46.2%)	251 (100%)
All age	1522 (5.8%)	5031 (19.3%)	1937 (7.4%)	17581 (67.4%)	26071 (100%)
Female, Male or Unknown					
16-17	743 (17.7%)	796 (19%)	579 (13.8%)	2077 (49.5%)	4195 (100%)
18-20	1255 (16.2%)	1530 (19.7%)	1181 (15.2%)	3788 (48.9%)	7754 (100%)
21-24	977 (13.3%)	1463 (20%)	950 (13%)	3940 (53.8%)	7330 (100%)
25+	3099 (6.5%)	9574 (20.1%)	3784 (8%)	31092 (65.4%)	47549 (100%)
Unknown	109 (16.2%)	156 (23.2%)	100 (14.9%)	306 (45.6%)	671 (100%)
All age	6183 (9.2%)	13519 (20%)	6594 (9.8%)	41203 (61%)	67499 (100%)

Table B6: Distribution of time of crash by driver age and sex for New Zealand data, for all serious casualty crashes only

Age/sex groups	Weekend Night	Weekend Day	Weekday Night	Weekday Day	Total
Male					
16-17	73 (23.2%)	62 (19.7%)	66 (21%)	114 (36.2%)	315 (100%)
18-20	165 (28.6%)	94 (16.3%)	139 (24.1%)	178 (30.9%)	576 (100%)
21-24	135 (27.5%)	91 (18.5%)	110 (22.4%)	155 (31.6%)	491 (100%)
25+	353 (13%)	592 (21.8%)	414 (15.3%)	1352 (49.9%)	2711 (100%)
Unknown	10 (23.3%)	5 (11.6%)	8 (18.6%)	20 (46.5%)	43 (100%)
All age	736 (17.8%)	844 (20.4%)	737 (17.8%)	1819 (44%)	4136 (100%)
Female					
16-17	24 (18.5%)	20 (15.4%)	25 (19.2%)	61 (46.9%)	130 (100%)
18-20	28 (11.9%)	44 (18.7%)	45 (19.1%)	118 (50.2%)	235 (100%)
21-24	24 (11%)	50 (22.9%)	30 (13.8%)	114 (52.3%)	218 (100%)
25+	106 (6.1%)	372 (21.4%)	165 (9.5%)	1097 (63%)	1740 (100%)
Unknown	2 (9.5%)	6 (28.6%)	4 (19%)	9 (42.9%)	21 (100%)
All age	184 (7.8%)	492 (21%)	269 (11.5%)	1399 (59.7%)	2344 (100%)
Female, Male or Unknown					
16-17	98 (22%)	82 (18.4%)	91 (20.4%)	175 (39.2%)	446 (100%)
18-20	193 (23.7%)	139 (17.1%)	184 (22.6%)	297 (36.5%)	813 (100%)
21-24	160 (22.5%)	142 (19.9%)	140 (19.7%)	270 (37.9%)	712 (100%)
25+	459 (10.3%)	968 (21.6%)	584 (13.1%)	2461 (55%)	4472 (100%)
Unknown	12 (18.8%)	11 (17.2%)	12 (18.8%)	29 (45.3%)	64 (100%)
All age	922 (14.2%)	1342 (20.6%)	1011 (15.5%)	3232 (49.7%)	6507 (100%)

Table B7: Distribution of crashes occurring at night on weekends and at night on weekdays for males and females separated by serious all crash severities and New Zealand data

Weekend Night			
Age	Serious Crash	All Crash Severities	% of crashes that are serious
16-17	98	743	13.19%
18-20	193	1255	15.38%
21-24	160	977	16.38%
25+	459	3099	14.81%
All ages	922	6183	14.91%
Weekday Night			
	Serious	All Crash Severities	% of crashes that are serious
16-17	91	579	15.72%
18-20	184	1181	15.58%
21-24	140	950	14.74%
25+	584	3784	15.43%
All ages	5256	98508	5.34%

Table B8: Distribution of New Zealand data for time of crash by vehicle age group and sex for all serious injury crashes for drivers aged 16-24 years

Sex	Vehicle Age	Weekend Night	Weekend Day	Weekday Night	Weekday Day
Male	0-3 years	3 (0.8%)	0 (0%)	5 (1.6%)	14 (3.3%)
	3 to 5 years	4 (1.1%)	4 (1.7%)	7 (2.3%)	6 (1.4%)
	6 to 10 years	82 (22.8%)	37 (15.5%)	68 (22.1%)	90 (21.1%)
	11 to 15 years	173 (48.2%)	120 (50.2%)	127 (41.2%)	181 (42.4%)
	16 years & over	97 (27%)	78 (32.6%)	101 (32.8%)	136 (31.9%)
	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	359 (100%)	239 (100%)	308 (100%)	427 (100%)
Female	0-3 years	1 (1.4%)	2 (1.9%)	1 (1%)	4 (1.4%)
	3 to 5 years	0 (0%)	4 (3.7%)	1 (1%)	4 (1.4%)
	6 to 10 years	18 (24.3%)	28 (25.9%)	15 (15.5%)	82 (28.5%)
	11 to 15 years	39 (52.7%)	51 (47.2%)	47 (48.5%)	115 (39.9%)
	16 years & over	16 (21.6%)	23 (21.3%)	33 (34%)	83 (28.8%)
	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	74 (100%)	108 (100%)	97 (100%)	288 (100%)
M, F or Unknown					
	0-3 years	4 (0.9%)	3 (0.9%)	6 (1.5%)	18 (2.5%)
	3 to 5 years	4 (0.9%)	8 (2.3%)	8 (2%)	10 (1.4%)
	6 to 10 years	102 (23.4%)	65 (18.6%)	83 (20.5%)	173 (24.1%)
	11 to 15 years	212 (48.7%)	171 (49%)	174 (43%)	296 (41.3%)
	16 years & over	113 (26%)	102 (29.2%)	134 (33.1%)	220 (30.7%)
	Unknown	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	435 (100%)	349 (100%)	405 (100%)	717 (100%)

Table B10: Distribution of road user involvement of crash by driver age and sex for New Zealand data for all crash severities

Age/sex groups	Cyclist/Vehicle	Pedestrian/Vehicle	Multi-vehicle	Single-vehicle	Total
Male	88 (3.2%)	170 (6.1%)	1475 (53%)	1051 (37.8%)	2784 (100%)
16-17	161 (3.1%)	289 (5.6%)	2797 (54%)	1929 (37.3%)	5176 (100%)
18-20	145 (3.1%)	299 (6.4%)	2755 (59.1%)	1461 (31.4%)	4660 (100%)
21-24	1303 (4.8%)	1980 (7.2%)	19006 (69.5%)	5044 (18.5%)	27333 (100%)
25+	9 (2.1%)	21 (5%)	173 (41.1%)	218 (51.8%)	421 (100%)
Unknown	1706 (4.2%)	2759 (6.8%)	26206 (64.9%)	9703 (24%)	40374 (100%)
All age	88 (3.2%)	170 (6.1%)	1475 (53%)	1051 (37.8%)	2784 (100%)
Female					
16-17	40 (2.8%)	73 (5.1%)	762 (53.2%)	558 (38.9%)	1433 (100%)
18-20	87 (3.3%)	138 (5.3%)	1611 (61.6%)	779 (29.8%)	2615 (100%)
21-24	104 (3.8%)	160 (5.9%)	1808 (66.9%)	632 (23.4%)	2704 (100%)
25+	1007 (5.2%)	1327 (6.9%)	13815 (71.7%)	3107 (16.1%)	19256 (100%)
Unknown	7 (2.8%)	8 (3.2%)	109 (43.4%)	127 (50.6%)	251 (100%)
All age	1245 (4.7%)	1706 (6.5%)	18105 (68.9%)	5203 (19.8%)	26259 (100%)
Female, Male or Unknown					
16-17	128 (3%)	243 (5.8%)	2240 (53.1%)	1610 (38.1%)	4221 (100%)
18-20	248 (3.2%)	428 (5.5%)	4420 (56.6%)	2713 (34.7%)	7809 (100%)
21-24	249 (3.4%)	460 (6.2%)	4577 (61.9%)	2103 (28.5%)	7389 (100%)
25+	2499 (5.2%)	3504 (7.3%)	33611 (70.2%)	8288 (17.3%)	47902 (100%)
Unknown	16 (2.4%)	29 (4.3%)	284 (42.1%)	346 (51.3%)	675 (100%)
All age	3140 (4.6%)	4664 (6.9%)	45132 (66.4%)	15060 (22.1%)	67996 (100%)

Table B11: Distribution of road user involvement of crash by driver age and sex for New Zealand data for all serious injury crashes

Age/sex groups	Cyclist/Vehicle	Pedestrian/Vehicle	Multi-vehicle	Single-vehicle	Total
Male	0 (0%)	4 (1.3%)	141 (44.5%)	172 (54.3%)	317 (100%)
16-17	0 (0%)	7 (1.2%)	228 (39%)	350 (59.8%)	585 (100%)
18-20	0 (0%)	3 (0.6%)	207 (41.7%)	286 (57.7%)	496 (100%)
21-24	1 (0%)	15 (0.5%)	1610 (58.7%)	1115 (40.7%)	2741 (100%)
25+	0 (0%)	0 (0%)	7 (15.9%)	37 (84.1%)	44 (100%)
Unknown	1 (0%)	29 (0.7%)	2193 (52.4%)	1960 (46.9%)	4183 (100%)
All age	0 (0%)	4 (1.3%)	141 (44.5%)	172 (54.3%)	317 (100%)
Female					
16-17	0 (0%)	1 (0.8%)	59 (45.4%)	70 (53.8%)	130 (100%)
18-20	0 (0%)	0 (0%)	125 (52.3%)	114 (47.7%)	239 (100%)
21-24	0 (0%)	3 (1.4%)	114 (52.3%)	101 (46.3%)	218 (100%)
25+	2 (0.1%)	6 (0.3%)	1160 (66%)	589 (33.5%)	1757 (100%)
Unknown	0 (0%)	0 (0%)	7 (33.3%)	14 (66.7%)	21 (100%)
All age	2 (0.1%)	10 (0.4%)	1465 (61.9%)	888 (37.5%)	2365 (100%)
Female, Male or Unknown					
16-17	0 (0%)	5 (1.1%)	200 (44.6%)	243 (54.2%)	448 (100%)
18-20	0 (0%)	7 (0.8%)	354 (42.9%)	465 (56.3%)	826 (100%)
21-24	0 (0%)	6 (0.8%)	322 (44.9%)	389 (54.3%)	717 (100%)
25+	3 (0.1%)	21 (0.5%)	2784 (61.6%)	1711 (37.9%)	4519 (100%)
Unknown	0 (0%)	0 (0%)	14 (21.5%)	51 (78.5%)	65 (100%)
All age	3 (0%)	39 (0.6%)	3674 (55.9%)	2859 (43.5%)	6575 (100%)

Table B12: Distribution of single-vehicle crashes for males and females separated by serious and all crash severities, New Zealand data

Age	Serious	All	% of crashes that are serious
16-17	243	1610	15.09%
18-20	465	2713	17.14%
21-24	389	2103	18.50%
25+	1711	8288	20.64%
All ages	2808	14714	19.08%

Table B19: Distribution of the road surface condition at the crash location by driver age and sex for New Zealand data and for all crash severities

Age/sex groups	Unknown	Dry	Ice/Snow	Wet	Total
Male	8 (0.3%)	1905 (68.4%)	19 (0.7%)	855 (30.7%)	2787 (100%)
16-17	16 (0.3%)	3609 (69.6%)	35 (0.7%)	1526 (29.4%)	5186 (100%)
18-20	18 (0.4%)	3222 (69%)	44 (0.9%)	1384 (29.6%)	4668 (100%)
21-24	98 (0.4%)	19860 (72.5%)	294 (1.1%)	7139 (26.1%)	27391 (100%)
25+	0 (0%)	316 (74.9%)	2 (0.5%)	104 (24.6%)	422 (100%)
Unknown	140 (0.3%)	28912 (71.5%)	394 (1%)	11008 (27.2%)	40454 (100%)
All age	8 (0.3%)	1905 (68.4%)	19 (0.7%)	855 (30.7%)	2787 (100%)
Female	3 (0.2%)	1005 (69.9%)	12 (0.8%)	418 (29.1%)	1438 (100%)
16-17	7 (0.3%)	1784 (68.1%)	24 (0.9%)	804 (30.7%)	2619 (100%)
18-20	10 (0.4%)	1871 (69.1%)	33 (1.2%)	794 (29.3%)	2708 (100%)
21-24	50 (0.3%)	13989 (72.5%)	212 (1.1%)	5046 (26.1%)	19297 (100%)
25+	1 (0.4%)	190 (75.4%)	0 (0%)	61 (24.2%)	252 (100%)
Unknown	71 (0.3%)	18839 (71.6%)	281 (1.1%)	7123 (27.1%)	26314 (100%)
All age	3 (0.2%)	1005 (69.9%)	12 (0.8%)	418 (29.1%)	1438 (100%)
Female, Male or Unknown					
16-17	11 (0.3%)	2913 (68.9%)	31 (0.7%)	1274 (30.1%)	4229 (100%)
18-20	23 (0.3%)	5409 (69.1%)	59 (0.8%)	2332 (29.8%)	7823 (100%)
21-24	28 (0.4%)	5111 (69.1%)	77 (1%)	2185 (29.5%)	7401 (100%)
25+	162 (0.3%)	34802 (72.5%)	509 (1.1%)	12530 (26.1%)	48003 (100%)
Unknown	1 (0.1%)	509 (75.2%)	2 (0.3%)	165 (24.4%)	677 (100%)
All age	225 (0.3%)	48744 (71.5%)	678 (1%)	18486 (27.1%)	68133 (100%)

Table B20: Distribution of New Zealand data for road surface condition at the crash location by driver age and sex for serious crashes only

Age/sex groups	Unknown	Dry	Ice/Snow	Wet	Total
Male	0 (0%)	216 (68.1%)	2 (0.6%)	99 (31.2%)	317 (100%)
16-17	3 (0.5%)	388 (66.3%)	5 (0.9%)	189 (32.3%)	585 (100%)
18-20	3 (0.6%)	332 (66.9%)	9 (1.8%)	152 (30.6%)	496 (100%)
21-24	8 (0.3%)	1900 (69.3%)	48 (1.8%)	785 (28.6%)	2741 (100%)
25+	0 (0%)	32 (72.7%)	1 (2.3%)	11 (25%)	44 (100%)
Unknown	14 (0.3%)	2868 (68.6%)	65 (1.6%)	1236 (29.5%)	4183 (100%)
All age	0 (0%)	216 (68.1%)	2 (0.6%)	99 (31.2%)	317 (100%)
Female	1 (0.8%)	92 (70.2%)	0 (0%)	38 (29%)	131 (100%)
16-17	0 (0%)	155 (64.9%)	6 (2.5%)	78 (32.6%)	239 (100%)
18-20	0 (0%)	141 (64.7%)	6 (2.8%)	71 (32.6%)	218 (100%)
21-24	4 (0.2%)	1221 (69.4%)	42 (2.4%)	492 (28%)	1759 (100%)
25+	1 (4.8%)	15 (71.4%)	0 (0%)	5 (23.8%)	21 (100%)
Unknown	6 (0.3%)	1624 (68.6%)	54 (2.3%)	684 (28.9%)	2368 (100%)
All age	1 (0.8%)	92 (70.2%)	0 (0%)	38 (29%)	131 (100%)
Female, Male or Unknown					
16-17	1 (0.2%)	309 (68.8%)	2 (0.4%)	137 (30.5%)	449 (100%)
18-20	3 (0.4%)	544 (65.9%)	11 (1.3%)	268 (32.4%)	826 (100%)
21-24	3 (0.4%)	475 (66.2%)	15 (2.1%)	224 (31.2%)	717 (100%)
25+	12 (0.3%)	3137 (69.4%)	90 (2%)	1282 (28.4%)	4521 (100%)
Unknown	1 (1.5%)	47 (72.3%)	1 (1.5%)	16 (24.6%)	65 (100%)
All age	20 (0.3%)	4512 (68.6%)	119 (1.8%)	1927 (29.3%)	6578 (100%)

APPENDIX C: SCENARIO 2a & 2b TABLES

Table C1: Most-crashworthy vehicle for by year of manufacture (1982-2006)

Year Of Manufacture	Make	Model	Years Manufactured	Market Group	Crashworthiness (%)
1982	Peugeot	505	82-93	Medium	2.50
1983	Peugeot	505	82-93	Medium	2.50
1984	Volvo	700/900 Series	84-92	Large	2.44
1985	Volvo	700/900 Series	84-92	Large	2.44
1986	Saab	9000	86-97	Medium	1.51
1987	Saab	9000	86-97	Medium	1.51
1988	Saab	9000	86-97	Medium	1.51
1989	Saab	9000	86-97	Medium	1.51
1990	Saab	9000	86-97	Medium	1.51
1991	Saab	9000	86-97	Medium	1.51
1992	Saab	9000	86-97	Medium	1.51
1993	Mazda	MPV	93-99	People Mover	1.00
1994	Mazda	MPV	93-99	People Mover	1.00
1995	Mazda	MPV	93-99	People Mover	1.00
1996	Mazda	MPV	93-99	People Mover	1.00
1997	Mazda	MPV	93-99	People Mover	1.00
1998	Mazda	MPV	93-99	People Mover	1.00
1999	Kia	Carnival	99-06	People Mover	0.93
2000	Kia	Carnival	99-06	People Mover	0.93
2001	Kia	Carnival	99-06	People Mover	0.93
2002	Kia	Carnival	99-06	People Mover	0.93
2003	Kia	Carnival	99-06	People Mover	0.93
2004	Volkswagen	Golf / Jetta	04-06	Small	0.55
2005	Volkswagen	Golf / Jetta	04-06	Small	0.55
2006	Volkswagen	Golf / Jetta	04-06	Small	0.55

Table C2: Most-crashworthy 4WD's by year of manufacturer

Year of Manufacture	Make	Crashworthiness (%)
4WD - Compact		
1982-1993	Nil	
1994-1996	Toyota RAV4 (94-00)	0.03
1997-2001	Honda CR-V (97-01)	0.02
2002-2006	Honda CR-V (02-06)	0.02
4WD - Large		
1982-1987	Land Rover Range Rover (82-94)	0.03
1988-1994	Nissan / Ford Patrol / Maverick (88-97 / 88-97)	0.03
1995-1997	Land Rover Range Rover (95-02)	0.02
1998-2000	Mercedes Benz M-Class W163 (98-05)	0.01
2001-2005	Ford Explorer (01-05)	0.01
2006	Nissan Patrol (98-06)	0.02
4WD - Medium		
1982-1990	Jeep Cherokee XJ (82-01)	0.03
1991-1994	Land Rover Discovery (91-02)	0.02
1995-1999	Toyota Landcruiser Prado (96-03)	0.02
2000-2002	Mitsubishi Pajero NM / NP / NS (00-06)	0.02
2003-2006	Toyota Landcruiser Prado (03-06)	0.02

Table C3: Most-crashworthy vehicle for by year of manufacture and vehicle market group

Year Of Manufacture	Make	Crashworthiness (%)
Commercial - Ute		
1982-1992	Ford Ford F-Series (82-92)	0.03
1993-1995	Nil	
1996-2002	Mitsubishi Triton MK (96-06)	0.02
2003-2006	Ford Falcon Ute BA/BF (03-06)	0.02
Commercial - Van		
1982-1994	Nil	
1995-2000	Volkswagen Caravelle / Transporter (95-04)	0.01
2001-2006	Ford Transit (01-06)	0.01
Large		
1982-1983	Nil	
1984-1986	Volvo 700/900 Series (84-92)	0.02
1987-1994	Jaguar XJ6 (87-94)	0.02
1995-1998	BMW 7 Series E38 (95-01)	0.01
1999-2000	Hyundai Grandeur (99-00)	0.01
2001	BMW 7 Series E38 (95-01)	0.01
2002	Holden Statesman/Caprice WH (99-03)	0.02
2003-2005	Mitsubishi Magna TL/TW / Verada KL/KW (03-05)	0.02
2006	Toyota Camry (02-06)	0.02

Table C4: Most-crashworthy vehicle for by year of manufacture and vehicle market group

Year Of Manufacture	Make	Crashworthiness (%)
Luxury		
1982-1983	Peugeot 505 (82-93)	0.02
1984-1985	Volvo 700/900 Series (84-92)	0.02
1986-1995	Saab 9000 (86-97)	0.02
1996-2004	Peugeot 406 (96-04)	0.01
2005-2006	Volkswagen Passat (98-06)	0.01
Medium		
1982-1985	Peugeot 505 (82-93)	0.02
1986-1995	Saab 9000 (86-97)	0.02
1996-2004	Peugeot 406 (96-04)	0.01
2005-2006	Volkswagen Passat (98-06)	0.01
People Mover		
1982-1990	Nil	
1991	Toyota Tarago (91-99)	0.03
1992	Nissan Serena (92-95)	0.02
1993-1998	Mazda MPV (93-99)	0.01
1999-2006	Kia Carnival (99-06)	0.01
Small		
1982-1993	Nil	
1994-1996	Peugeot 306 (94-01)	0.02
1997-1999	Audi A3/S3 (97-04)	0.01
2000-2003	Volkswagen New Beetle (00-06)	0.01
2004-2006	Volkswagen Golf / Jetta (04-06)	0.01
Light		
1982-2006	Nil	
Sports		
1982-2006	Nil	

Appendix D: Cost of vehicles purchased under scenario 2a

Table D1: Cost of vehicles purchased under Scenario 2a

	Make and model description	CWR	Price Range Early model or Ave. Condition	Early model or Ave. Condition
4WD - Compact				
1982-1993	Nil			
1994-1996	Toyota RAV4 (94-00)	3.02%	$3,000	$5,600
1997-2001	Honda CR-V (97-01)	2.13%	$5,800	$10,000
2002-2006	Honda CR-V (02-06)	1.78%	$11,000	$20,000
4WD - Large				
1982-1987	Land Rover Range Rover (82-94)	2.70%	$1,300	$4,600
1988-1994	Nissan / Ford Patrol / Maverick (88-97)	2.57%	$2,800	$7,800
1995-1997	Land Rover Range Rover (95-02)	1.53%	$7,500	$11,400
1998-2000	Mercedes Benz M-Class W163 (98-05)	1.15%	$10,100	$13,700
2001-2005	Ford Explorer (01-05)	1.02%	$7,400	$25,800
2006	Nissan Patrol (98-06)	2.07%	$28,900	$32,000
4WD - Medium				
1982-1990	Jeep Cherokee XJ (82-01)	2.69%	$1,700	$4,300
1991-1994	Land Rover Discovery (91-02)	2.08%	$1,700	$4,400
1995-1999	Toyota Landcruiser Prado (96-03)	1.72%	$8,500	$9,900
2000-2002	Mitsubishi Pajero NM / NP / NS (00-06)	1.64%	$8,700	$33,000
2003-2006	Toyota Landcruiser Prado (03-06)	1.56%	$16,300	$33,700
Commercial - Ute				
1982-1992	Ford Ford F-Series (82-92)	2.58%	$1,900	$10,700
1993-1995	Nil			
1996-2002	Mitsubishi Triton MK (96-06)	2.15%	$2,900	$5,500
2003-2006	Ford Falcon Ute BA/BF (03-06)	1.77%	$8,000	$15,400
Commercial - Van				
1982-1994	Nil			
1995-2000	Volkswagen Caravelle/Transporter (95-04)	1.46%	$3,600	$8,500
2001-2006	Ford Transit (01-06)	1.32%	$8,700	$22,700
Large				
1982-1983	Nil			
1984-1986	Volvo 700/900 Series (84-92)	2.44%	$1,000	$1,800
1987-1994	Jaguar XJ6 (87-94)	2.06%	$3,600	$12,600
1995-1998	BMW 7 Series E38 (95-01)	1.20%	$9,500	$16,600
1999-2000	Hyundai Grandeur (99-00)	0.95%	$3,700	$6,600
2001	BMW 7 Series E38 (95-01)	1.20%	$17,700	$24,200
2002	Holden Statesman/Caprice WH (99-03)	1.91%	$9,100	$10,700
2003-2005	Mitsubishi Magna TL/TW / Verada KL/KW (03-05)	1.74%	$6,800	$10,000
2006	Toyota Camry (02-06)	2.23%	$15,200	$17,200
Luxury				
1982-1983	Peugeot 505 (82-93)	2.50%	$800	$1,700
1984-1985	Volvo 700/900 Series (84-92)	2.44%	$1,000	$2,300
1986-1995	Saab 9000 (86-97)	1.51%	$1,100	$4,000
1996-2004	Peugeot 406 (96-04)	1.21%	$2,600	$18,600

	Make and model description	CWR	Price Range Early model or Ave. Condition	Early model or Ave. Condition
2005-2006	Volkswagen Passat (98-06)	1.36%	$18,500	$29,900
Medium				
1982-1985	Peugeot 505 (82-93)	2.50%	$800	$2,000
1986-1995	Saab 9000 (86-97)	1.51%	$1,100	$4,000
1996-2004	Peugeot 406 (96-04)	1.21%	$2,600	$18,600
2005-2006	Volkswagen Passat (98-06)	1.36%	$18,500	$29,900
People Mover				
1982-1990	Nil			
1991	Toyota Tarago (91-99)	2.88%	$3,500	$5,300
1992	Nissan Serena (92-95)	2.09%	$1,700	$3,900
1993-1998	Mazda MPV (93-99)	1.00%	$4,100	$9,000
1999-2006	Kia Carnival (99-06)	0.93%	$3,300	$22,000
Small				
1982-1993	Nil			
1994-1996	Peugeot 306 (94-01)	2.10%	$1,600	$3,700
1997-1999	Audi A3/S3 (97-04)	1.42%	$5,100	$8,500
2000-2003	Volkswagen New Beetle (00-06)	1.00%	$10,200	$14,400
2004-2006	Volkswagen Golf / Jetta (04-06)	0.55%	$13,850	$19,400
Light				
1982-2006	Nil			
Sports				
1982-2006	Nil			